HOW TO OBSERVE GOTHIC ARCHITECTURE.

NEARLY all the religious edifices of which there are any remains, were built after the restoration of the arts in the beginning of the eleventh century. From that period the church has always presented nearly the same arrangements, and these have their type, except in the proportions and style, in the Roman basilica. This distribution has not received, even to our own day, more than one important modification by the prolongation of the collateral aisles of the choir, which dates from the first years of the 12th century.

The more rare the churches constructed on any other plan, the more carefully they ought to be studied when met with.

From the beginning of the eleventh century, our churches having taken proportions more and more extended, and more suited to the population crowding to them, the union of the works of many generations, and often of many centuries, are to be found in their construction. Each of these ages and generations, disdaining to acknowledge the authority of an age less civilized, especially in details, modified the preceding plans, which, in fact, had not been rigorously followed, and impressed a peculiar character on its own works.

It is then in the details that we must search for peculiar characteristics, both in the exterior and interior, that is, in every portion of the structure, which is generally complicated, and almost always heterogeneous. That we may not wander in an analysis, it is necessary to conduct it with order. We think that it may be proceeded with after the plan traced out in the following divisions.

CHAP. I. The ensemble of the Church.
„ II. A full account of the examination of the exterior.
„ III. A full account of the examination of the interior.
„ IV. The dependencies, accessory constructions, or analogies.

I. THE ENSEMBLE OF A CHURCH.

This subject may be comprised under five distinct heads:

1. The eastern position of the edifice.
2. The ground plan.
3. The general dimensions.
4. The general system and materials of construction.
5. The general distribution.

1. *The Eastern Position of the Edifice.*—Every one knows that a long time before the 11th century the churches were built as much as possible facing the east; whether it was that the sun should light the interior with his first rays, or that those who worshipped might have their faces towards that country which was the cradle of Christianity, there may be some doubt. Whenever a church has been constructed since that epoch in any other position, it has been on account of some peculiarity in the situation. We think that an account should be kept of every inclination, often very marked, of the axis of the church from the true east; an incorrectness which may arise, either from the little care bestowed by the builders to determine the exact orientation, or, as some antiquaries have supposed, from a slight change in the point of the heavens where the sun rose. If the churches were always built from east to west, except this trifling inaccuracy, it would be sufficient to mention the names of the cardinal points, to avoid all confusion in the description of the respective situations of the parts, and especially of those which are repeated on each side of the axis. But as it is not always so, architectural writers have adopted distinct terms, for the purpose of avoiding all confusion. Thus it is said, that an object is on the right or epistle side of the axis of the church when it stands to the right of an observer who has his face turned to the chancel; and on the gospel side when on his left. If the church be situated in the true east and west, we may, without inconvenience, make use of the expressions southern and northern, which has the advantage of giving the relative orientation, and the absolute orientation of the points in question.

2. *Ground Plan.*—Whenever it is possible to furnish a plan of a church of importance or interest, much delay and obscurity of description will be prevented. It is desirable that all plans should be formed on some fixed scale. It will be very useful to distinguish by a particular kind of wash, the portions of the edifice belonging to each epoch, and to each system of construction.

In proceeding with this work it must also be constantly remembered, that the architects of the middle ages did not, for some cause, which we need not here investigate, adopt any regularity of construction in the spaces and dimensions of the several portions of their edifices. For this reason it will be necessary to measure scrupulously every part of the edifice. We particularly recommend the antiquary to examine whether the collaterals are of an equal breadth, and whether the choir does not present some deviation more or less decided from the principal axis of the church.

3. *General Dimensions.*—Although the length and breadth are furnished in the plan mentioned in the preceding paragraph, it will be well to state them in figures, so as to give an opportunity of comparing them with the third dimension, the height. We also think that it would be well to connect these three dimensions with those of the principal members of the edifice.

4. *General System and Materials for Constructions.*—Whatever may be the diversity of style and date of the several parts which compose a church, they nearly always offer a principal mass, which will furnish the opportunity of making interesting observations upon

1. The geological nature of the material used in masonry.
2. The place of extraction.
3. The period of its common employment in the district or county.
4. The dimension of the masses.
5. The form.
6. The colour.
7. The disposition.

The depth and the profile of the joints.

The composition and solidity of the mortars and cements.

The regularity of the lines of joints.

The existence of a distinct base, its height, its projection, and the moulding which terminates it.

The sets-off or projections which present themselves at different heights of the face of the wall.

The antiquary should be careful to observe every example of herring-bone (the *opus spicatum* of the ancients), composed of materials alternately inclined on opposite sides, and also the *opus reticulatum*, formed of square pieces placed upon one of their angles, in a word, an irregularity of figure. The *opus reticulatum* is met with in the works of the middle ages in friezes, arcades, tympanums of doors, and other parts slightly decorated. Sometimes it is only represented by light furrows cut upon a stone of large dimensions:—

All the exterior and interior portions of a church should be examined separately, under the several heads yet to be mentioned, whenever it presents characters of a kind differing from those of the principal mass.

5. *General Distribution.*—The principal parts constituting a complete church are the following:—

A, The apside, *chevet*, or sanctuary.

B, The choir.
C, The principal nave.
D, The collaterals of the nave and their chapels.
E, The transepts and their chapels.
F, The portal.
G, The porch.
H, The belfries.
I, The sacristy or vestry.

A, The Apside, Chevet, or Sanctuary.—In the churches of the 11th and 12th centuries, as in the Roman basilicas, the end of the building consists of an apside, or a semicircular tribune, and is attached to the principal construction by a spherical vault, surmounted by a roof, nearly always lower than that of the choir, while the ground is, on the contrary, more elevated. About the centre of the apside was commonly placed the altar, and at the bottom of it the chair of the bishop, abbot, or curé, the priest being seated at his right and left, and the deacons about the two sides of the altar, with their faces turned towards the people.

We have said that the plan of the apside was semicircular, but there are some very old churches in which it is triangular, square, or formed of a greater number of parts, at least on the exterior.

Originally this part of the edifice was not pierced by any windows; but, from an early period, lights were introduced, and it became customary to have one or more, commonly an odd number.

At an early period, also, there were constructed, chiefly in rural districts, churches without apsides, (*chevet plat*), in which the clergyman officiating was necessarily always placed with his face towards the east.

It is known that in some very ancient apsides the primitive altar was placed with its back to the wall. Nevertheless, this situation of the clergy, which appears to have been purely accidental, became general when the new mode of distribution which we have mentioned, in surrounding the sanctuary with the prolongation of the collateral, and a complete series of chapels, gave to it the form the use of which is preserved to our own day, and which leaves to us no other characters of its ancient destination than the presence of the altar and the celebration of divine worship.

In the abbey churches, and above all in the nunneries, the high choir was often placed behind the altar.

B, the Choir.—The choir, originally situated at the top of the nave, is, in the Roman and Gothic churches, the portion of the edifice intermediate between the apside or the sanctuary, and the intersection of the transepts with the principal nave. Its original destination was exclusively to receive the singers and the inferior officers in the performance of worship, which we now call the second choir. In the churches of the eleventh and twelfth centuries, it may be seen that the roof, more elevated than the apside, was generally less than the principal nave. In the interior, the inclosure which forms its entrance, and which was originally formed of open-work in stone, caused it to be called, in the middle ages, the chancel. Its form and its dimensions have undergone some important changes, for, by the revolution mentioned above, it has been appropriated to all the clergy.

In the cathedrals, great abbeys, and even in some parish churches, the choir terminates at the side of the nave by the *jubé*, the tribune where the gospel is read on solemn festivals, and which replaces the *ambons* of the primitive uses. The formation of this tribune, which does not go back to any high antiquity, was put up with the design of freeing the reading of the gospel from the mystery with which the other ceremonies of divine worship were surrounded by the enclosure of the choir.

C, The principal Nave.—This portion of the edifice, of which the plan is, in the Latin church, a parallelogram more or less lengthened, forms, as it were, the central nave, on which all the accessary constructions repose. It is commonly the most elevated part, at least in the Roman distribution, and is that which has since for many centuries received the mass of worshippers, before placed on the right and left hand in the collateral, so as to leave the principal nave completely free.

D, The Collateral.—The collateral, or secondary naves, are the two portions of the church parallel to the principal nave, and from which they are only separated by pillars or columns. In the Latin basilicas, they terminate suddenly at their point of intersection with the apside, by a transverse wall. In the Christian basilicas, these two walls are generally placed at the secondary apsides, formerly destined to receive, —one the treasures of the church, the other the sacristry.

The secondary naves are sometimes double in large edifices, that is, divided into two parts in their length by a range of intermediate pillars or colums; they are also often provided with superior galleries which double the extent.

They are wanting in the chapels, and in the greater number of churches of small dimensions.

E, The Transepts.—The transepts,—constructions transverse to the principal and collateral naves, as indicated by the name, and placed at the two sides of their extremity, near the choir, are found more or less marked in the primitive basilicas. They were at an early period adopted and developed by the Christian architects, to whom they gave an opportunity of impressing upon their edifices a peculiar character of religous consecration, by giving them the form of a cross. It was this that caused them to be called in France *la croisée* or *les croisillons* of the church.

After the introduction of the collateral naves, there were those which received the first and secondary altars introduced in Romish temples, of which the primitive rites allowed but one. Their apsides were often more characteristic and of greater dimensions than those of the collateral naves, destined, in the beginning, to another service.

The transepts are wanting in the chapels, and often in the smaller churches. In some large edifices there are two, so that the plan forms a sort of Lorraine or archiepiscopal cross.

It is said that a church is in the form of a Greek cross when the nave, the transepts, and the choir are of the same dimensions.

A Latin cross is that in which the nave is longer than the other part. This was the most common arrangement.

Sometimes the cross was reversed, and the *croisillon* choir was the longest.

(*To be continued.*)

AN HISTORICAL ACCOUNT OF THE PALACE OF VERSAILLES.

In the year 1561, the estate of Versailles became the property of Martial de Loménie, finance secretary to Charles IX., and he continued to possess it for a long time. L'Etoile, in his Memoirs, (tom. i. p. 26,) informs us, that Catherine de' Medicis caused him to be strangled, in order to bestow the estate upon the Comte de Retz. This is not perfectly authenticated, though it bears some appearance of truth. But, however this may be, it is certain that Albert de Gondi, Comte de Retz, one of those Florentines who followed the fortunes of Catherine into France, became proprietor of the castle and estate of Versailles. His son Jéan François de Gondi, archbishop of

Paris, and uncle of the Cardinal de Retz, sold it to Louis XIII. The following is an extract from the contract of sale :—

"The 8th April, 1632, the most illustrious and reverend Jéan François de Gondi, archbishop of Paris, seigneur of Versailles, now present, agrees to sell, yield up, &c., to Louis XIII., Messire Charles de l'Aubespine, keeper of the seals, and Messire Antoine Rusé, Marquis d'Effiat, superintendent of finances, accepting on the part of his Majesty, the lands and lordship of Versailles, consisting of an old chateau in ruins, and a farm with many buildings: the said farm comprising arable lands, meadows, woods, chestnut orchards, ponds, and other dependencies; with the homestead of Lessart, and its appurtenances, the said archbishop excepting, retaining or reserving nothing of what he possesses at Versailles, but the said domain of Versailles, &c., to be enjoyed by his said Majesty and his successors, as private property. This sale is herein verified to be for the sum of sixty-six thousand livres, which the said archbishop hereby acknowledges to have received from his said Majesty, by the hands of ————, in pieces of 16 sous, with which sum he holds himself content, and gives quittance to his Majesty and all others." (*Blondel, Arch. Franc.* liv. vii. p. 93.)

Louis XIII. had no intention of converting his new purchase into a royal residence, but merely a kind of hunting lodge. For this purpose his architect built a principal corps-de-logis and two wings, which form to this day that which is called the marble court, with the buildings and offices in the entrance court. This little chateau was found to be an agreeable and convenient residence. The towers at the corners, and the moat which surrounded it, as seen in a unique painting which has lately been brought from St. Petersburg, remind one of the feudal buildings of the preceding age.

It should here be observed, that it was not upon the exact site of the old chateau of Martial de Loménie, that Louis XIII. built his new habitation, but upon a piece of land which he bought from Jéan de Soisy, and which had been in the possession of his family from the 14th century. In the purchase of the chateau of Albert de Gondi, the intention was merely to pull it down, as it would have been an impediment to the royal residence. If tradition is to be believed, there formerly stood a windmill on the highest part of the plateau of Versailles, in the very place where the magnificent palace now rears its head: so that a miller was the predecessor of Louis XIV.

The resolution of this monarch to transform the little country house into one of the most noble palaces in Europe, caused much surprise among the courtiers: and was the occasion of numberless criticisms, though not openly expressed. Evidence of this secret opposition still remains. The situation appeared to be peculiarly ill chosen: "Versailles, dismal, ungrateful spot," said St. Simon, "destitute of wood, water, and even land itself, since all is either shifting sand or marsh, is unfit for any purpose."

Emboldened by the court, the architects stated to the king, that the palace of Louis XIII. was not solidly constructed: he replied, "I see plainly what you intend; if the building is in a bad state, let it come down, but it shall be rebuilt precisely in the same form." The chateau, however, was not demolished, but the two buildings were linked together so as to form one structure, yet they were kept so distinct that the view of one gave no suspicion of the existence of the other. Placed, as it were, back to back, the two buildings have only one façade.

An hereditary or dynastic feeling doubtless entered into this resolve of Louis XIV. He wished to carry as high as possible the historical and royal date of this palace which he had selected as his future residence; and he imposed upon his successors the conservative spirit which influenced him. We shall presently observe how it was subsequently felt and expressed by Napoleon.

The new constructions were commenced soon after the death of Cardinal Mazarin. The plans were furnished by Levenu, and were continued and amended by Mansard.

The palace was opened to the king and his court in the month of February, 1672, although it was then in an unfinished state.

According to the most moderate estimate, that of M. Janson, the architect, the total expense, comprising the purchase of land, the buildings, the river Eure, and the machine of Marly and Clagny, amounted to 86,668,726 livres, and that of the chapel to 3,260,342 livres, making a total of 89,929,068 livres. This sum did not include the cost of the opera-house, which was built under Louis XV., nor that of the *Rocher d'Apollon*, built under Louis XVI.

In estimating these expenses at the present day, at the increased value of materials and labour, they would amount to at least four hundred million francs.

But there is no documentary evidence by which we can arrive at an exact estimate of the whole expense incurred. Volney fixes it at four milliards, six hundred thousand francs. Mirabeau in his 19th Letter to his Constituents, carries the total amount to twelve hundred millions.

In the estimate of M. Janson, the statues and paintings are estimated to amount to 6,517,000 francs.

Louis XIV. lived in the palace of Versailles fifty-three years. The Regent never left his palace in Paris. But Louis XV., whose reign was as long as that of his predecessor, made Versailles his habitual residence. This monarch added some dependencies, made many internal alterations, and ordered it to undergo a general renovation, which work was entrusted to the architect Gabriel, who confined himself to the construction of a single pavilion, and a part of the wing near the chapel, executed in 1772 and 1774.

As soon as Louis XVI. ascended the throne, he wished to repair the palace of Versailles; and he undertook to replant the park, and decorate it with a garden in the English style, which was the fashion in 1780. He applied to the most celebrated architects of the time for plans for the restoration of this great building, the parts built by Louis XIII. being almost in ruins, and those of Louis XV. having been left in an unfinished state. All these plans, however, were of no avail; the Revolution arrived, and no more attention was paid to ancient monuments, except to destroy them. The palace of Versailles, despoiled of its treasures, remained for fifteen years entirely unoccupied, after having served as a hospital and a barrack.

When, in 1807, Napoleon wished to restore the palace of Louis XIV., he was startled at the cost of the undertaking. M. Gondoin, the skilful architect to whom Paris is indebted for the Ecole de Médecine, had made a comprehensive plan, which would have entailed an expense of fifty millions of francs. Saint Cloud, Fontainebleau, Compeigne, Rambouillet, and the two Trianons, had just been repaired and rendered habitable. The restoration of Versailles was therefore necessarily postponed, and only a few slight repairs, which were absolutely required for the preservation of the building, were undertaken at this time.

Four years afterwards, Napoleon having been crowned by fortune in his quarrel with Prussia and Austria, and having a successor to his throne, indulged the hope of peace, and among his projects was that of the restoration of Versailles. MM. Percier and Fontaine were charged with the undertaking. In July, 1811, the Emperor paid several visits to Versailles, and his state of uncertainty as to what ought to be done was increased by a personal observation of the diffi-

culties caused by the bad choice of Louis XIV. in the situation of his palace. The matter was still further adjourned. It was at this time, that after having visited all the apartments, even the smallest, the Emperor, startled by the disorder and confusion around, and conscious of the difficulties which were to be overcome, cried, "Why did not the Revolution destroy the palace of Versailles? I should not then have to-day a sin of Louis XIV. to trouble me, in the form of an old, ill-built palace,—a favourite without merit to enable us to endure it."

The campaign of 1812, which put the seal on the glory of France, was the means of stopping many grand constructive designs, among which the plans relating to the palace of Versailles may be particularly noticed.

Louis XVIII., on remounting the throne, wished Versailles to be immediately made habitable, and gave the most urgent orders to that effect. The easiest and least expensive plan appeared to be, to make a thorough repair of the gallery, the royal apartments, and all that Louis XIV. had built; to finish the façade looking towards Paris, which was begun by Gabriel, under Louis XV.; and to fit up the interior in the taste of the present day.

Such was the proposed plan; but the return of Napoleon in 1815 caused the works to be suspended for a short time. After the Hundred Days, they were resumed with activity, and in 1818, the façades and the principal dependencies of the palace, were entirely restored; the paintings on the ceilings of the grand apartments, and the gilding, were renovated, and the general arrangement made more convenient. In 1820, the pavilion corresponding to that of Louis XV. was built, the approaches cleared, and everything put in order: about six million francs were at this time expended. Nothing now remained but to furnish the palace, to render it habitable; but the works were entirely suspended under Charles X., and it remained in the state in which it was left by his predecessor, when the Revolution of July drove him from his throne.

Since that epoch, many projects have been indulged for the conversion of this striking emblem of absolute monarchy into a building of public utility. Some wished to turn it into a hospital for wounded and mutilated workmen,—an Hôtel d'Invalides, to rival that of Louis XIV.; others, to convert it into a model establishment for popular instruction; while others, again, urged the propriety of removing to it the Polytechnic and the other first-class schools of Paris. But none of these plans was adopted: the new monarch resolved to establish in the palace a vast historical museum.

To realize this plan, the old arrangements were necessarily modified, and the suites of small apartments were thrown into galleries and large saloons. The wainscots were regilt, the ceilings restored, the furniture completed, and numerous ancient and modern works of art, —paintings, busts, and statues, were brought together, and properly arranged in chronological order.

I may perhaps at some future time take a rapid glance at the riches of this immense collection, passing through the different saloons and galleries as nearly as possible in the order in which they are traversed by the visitor.

V.

REMARKS ON MR. PUGIN'S "APOLOGY FOR THE REVIVAL OF CHRISTIAN ARCHITECTURE IN ENGLAND."

Although Mr. Pugin seems to write more for the sake of making converts to his faith than for the purpose of teaching the beautiful art of which he is so excellent a master, we are always able to gain some solid practical information from his works. It is much to be regretted that he should so frequently present himself to his readers in all the repulsive attitudes of a bigot, and so continually dwell upon the now hackneyed tale of the deterioration of art with the revival of religion. No man so sincerely anxious to make converts ever pursued his object in so strange a manner—for men are not to be converted by abuse, nor can their errors be corrected by personal attacks upon their motives. Such a course is more calculated to excite anger, and to confirm prejudices, than to promote the cause of truth. These Protestant principles are really founded in a sound view of human nature, although they have not always been acted upon by those who have taken the guidance of mankind, either in the church or state. We do not quarrel with Mr. Pugin for having renounced all his right of private judgment, and submitted entirely to the control of his church, but we do complain that those who choose to exercise an independence of mind upon subjects which he thinks to be beyond the right of intellectual man, should be brought before *him* for judgment and condemnation. This is not said in a bitter spirit of retort, but rather with a desire to correct a great fault in a writer, who is, as an artist, worthy of esteem and confidence.

The high notions of the supremacy of the Romish church, so firmly fixed in the mind of this author, lead him into many great absurdities. Of this we have an instance in the assertion, that Gothic architecture has a claim "on our veneration and obedience, as the only correct expression of the faith, wants, and climate of our country." To dispute this statement with Mr. Pugin would occupy more space than we can devote to a question that can lead to no satisfactory result. To speak of the representation or expression of faith by a style of architecture is a pompous absurdity. Our knowledge of the mythology and architecture of the Egyptians, Greeks, and Romans, have enabled us to connect the one with the other; but we cannot imagine that an acquaintance with the mythology alone would enable an artist to represent the architecture. We are accustomed in this country to associate Gothic architecture with ecclesiastical uses, but in Rome, no such associations are acknowledged, and the best Italian architectural writers describe the style as the very "expression" of barbarism. "The belief and manners of all people," says Mr. Pugin, "are embodied in the edifices they raised; it was impossible for any of them to have built consistently otherwise than they did; each was the inventor and perfector of their peculiar style; each style was the type of the religion, customs, and climate." If religious opinions determine the character of national architecture, why is there not a similarity between the ecclesiastical structures of Italy and those of England in the eleventh, twelfth, and thirteenth centuries; and if customs and climate, why is there a resemblance between the ancient edifices of England, Germany, and France? This theory will not justify Mr. Pugin in his advocacy of Gothic architecture, and it may here be mentioned that, although it may suit his purpose to blame the Reformation for all the barbarities of architectural style introduced about that period, it cannot be forgotten that they were the offspring of Italian architects, true sons of the church, and as warmly attached as himself to the papal authority. Before he begins to talk to Protestants of their pagan architecture, let him teach the pope, cardinals, and priesthood of Rome. "I believe," says Mr. Pugin, that the various styles of pagan antiquity were "the perfect expressions of imperfect systems; the summit of human skill expended on human inventions; but I claim for christian art a merit and perfection, which it was impossible to attain even in the Mosaic dispensation." And yet this divine art or inspiration, as we must suppose it, being placed in opposition to a "human invention," has no existence in the dominions of him who is acknow-

edged by this author to be the vicegerent of heaven, and spiritual head of the church.

But although we cannot always agree with Mr. Pugin in his theoretical and religious notions, we are not the less admirers of the style he so much applauds, and it must be confessed that there is as much truth as bitterness in his criticisms upon modern art. The following remarks are peculiarly worthy of attention:

"Never, in the annals of architecture, have so many glorious opportunities offered, in a short space of time, for the accomplishment of noble buildings. Within my own recollection, three royal palaces, half the metropolis, churches without number, vast restorations, entire college, in both Universities, galleries, civic buildings, bridges, hospitals, houses. public monuments, in every possible variety; and with the exception of the New House of Parliament, we have not one edifice of the whole number that it is not painful to contemplate as a monument of national arts In no one instance has the purpose or destination of the building formed the groundwork of the composition: Grecian or Gothic, Ecclesiastical or Civil, it has been a mere system of adaptation."

Whatever opinion may be formed of the criticisms of Mr. Pugin, it must be allowed that he is fearless in the expression of them, and he seems to delight in attacking the errors of those who are by circumstances raised to the highest rank in the profession, and have therefore the greatest influence upon the public taste. The elevation of St. Paul's School he speaks of as "an unmeaning portico raised on stilts, serving only to darken the apartments over which it projects; an incipient dome, and a pagan frieze; and this wretched jumble of incongruities has cost twice the amount—and I speak advisedly—for which a truly appropriate structure, in accordance with the Founder's intentions, could have been erected." The New Royal Exchange he describes as "a stale dish of ill-assorted classicisms,—heavy, dull, and uninteresting."

There are some passages in this volume which are too painfully absurd and shocking to be dwelt upon. "Since Christ himself hung abandoned and bleeding on the cross of Calvary," says the author, "never has so sad a spectacle been exhibited to the afflicted Christian as is presented in many modern Catholic chapels, where the adorable victim is offered up by the priests of God's church disguised in miserable dresses intended for the sacred vestments, surrounded by a scoffing auditory of Protestant sight-seekers, who have paid a few shillings a head to grin at mysteries which they do not understand, and to hear the performances of an infidel troop of mercenary musicians, hired to sing symbols of a faith they disbelieve, and salutations to that Holy Sacrament they mock and deny." A more profane thought was perhaps never uttered. A man who can assert that the spectacle of a crucified Redeemer could be little more painful than the sight of priests in "miserable dresses," is, on such a subject, in a state of mind which places him out of the pale of criticism.

Mr. Pugin speaks with much complacency of the efforts being made by a section of the Anglican church to restore the ancient form of religious structure and worship. Let those who feel no degradation in being praised by the man who can make such a comparison as that which we have quoted, consider before it is too late the end of their treason to the Church and people of their country. This writer leaves us in no doubt as to the expectations of the Romanist from the fearful heresy at present existing in the English Church.

"If she (the Anglican Church) acted on her acknowledged doctrines and discipline, without even taking into consideration *any probable change in her position*, she must turn to Catholic antiquity for the types of her architecture and ornament.

"This argument is based on *principles and formularies*; for abuses cannot be either advanced or received in support of any position. I am not taking into account the various grades of opinion and practice that are unhappily to be found among those who act in the capacity of Anglican clergymen. I deal only with canons and rubrics; and if these were properly and universally carried out, a vast move would be made in the right direction."

Mr. Pugin, as a professor of the Romish faith, is consistent in the expression of his opinion, that the English churches should be restored to their state previous to the Reformation, but the same cannot be said of the Protestant clergy, if such they may be called, who are, by means of the Camden and other architectural societies, re-arranging and re-building our churches, with the intention of restoring the ancient superstitions and ceremonies which so long held the minds of our ancestors in spiritual bondage. We have too long kept terms with the men who are thus traitorously determined to sap the foundation of our religious liberties, and to pawn the interests of the established church of the realm, for canons and rubrics, forms and ceremonies. That such is the intention of the Puseyite clergy, there can now be no doubt, and the work before us is sufficient to convince any careful reader that it is a consummation in which the Romanists are deeply interested. Although yielding to none in our admiration of the ancient ecclesiastical structures, we boldly state that, after spending twenty years in the investigation of the finest specimens of English art, we would rather see every existing relic crumbled to dust, than entail upon our posterity the gross idolatry and foolish mummeries which our ancestors so nobly overthrew. One of the first questions that will open this momentous dispute, involving either the future glory or the degradation of our country, to the protestant population of England, will be the introduction of images in our Church, which Mr. Pugin defends on the assertion "that painting and sculpture, when devoted to the services of the church, are calculated to improve and elevate the religious feelings of a nation in a surprising degree!" We are at a loss to imagine where he can find an instance of this in the history of Europe. What has Romanism done for Ireland with all its idolatries, and what for Italy? These are its strongholds; and by the moral and mental conditions of the people in these countries let it be judged.

The anticipation of a re-union of the church of England with that of Rome, through the Puseyites of the present day, is clearly stated by Mr. Pugin in this volume; and that such is the intention of the leaders of the party, no one acquainted with their writings can doubt.

"There is something surely providential in the retention of the ancient titles and dignities; the daily chant of the divine office in the cathedrals and colleges; the dedication of churches in honour of the ancient saints; the consecration of ground for the burial of the dead; the preservation of the chapel and order of England's patron, St. George; the Catholic character of many portions of the liturgy, with its calendar of fasts and festivals; the solemn service and anointing of the sovereign at the coronation. These, and many more, seem so many pledges that God will not be angry with this land for ever; for there is no other instance of a country having fallen into the miserable state of Protestantism, having retained so much that is calculated to awaken in the breasts of her children a love and reverence for the past, and to lead them back to union with the see of blessed Peter, from whence the day star of truth first beamed upon us.

We have already lived to hear the name of Canterbury's blessed martyr pronounced with accents of veneration; a hundred pens, most ably wielded, are writing in defence of ancient piety and practice; a thousand voices are raised against the abominations of modern innovations. England is, indeed, awakening to a sense of her ancient dignity; she begins to appreciate the just merits of the past, and to work eagerly for the future. The last few years must, or ought to have, worked a great change in the feelings of English Catholics towards the Anglican churchmen; and it is evident, that if it be God's will that departed glories are to be restored, it will be effected rather by rebuilding the ruined walls of Zion, than by demolishing the poor remains that are left. The tide of popular innovation that so lately threatened us with common destruction, seems providentially stayed. God forbid that we should endeavour to obtain a transept in a scramble with dissenters, but rather prove ourselves to possess the feelings of the true mother in Solomon's judgment, and freely give up all, than see what we hold so dear divided; and by perfecting ourselves, and carrying out true Catholic principles in charity, devotion, and zeal, hasten forward that union, to which, in the words of an ecclesiastical periodical, we may even begin to look forward, and which is rather to be obtained through the sacrifice of the altar and

midnight supplication, than by the clamours of an election platform, or the tumult of popular commotion."

It is then for this re-union of the church of England with the see of Rome, that the architectural societies are labouring to restore and rebuild our parochial churches, after the model of ancient art. Mr. Pugin writes too plainly to be misunderstood; and, unwilling as we have been to admit theological discussions into a professional journal, no alternative is left but either to allow our art to become, without a warning, the means of restoring all the false doctrines, mummeries, and cruelties of Romanism into our land, or to make a bold stand against the specious pretensions of men who basely receive the bread of our clergy and curse our church. Mr. Pugin has done us good service by the publication of this volume—he has confirmed suspicions, roused us from a false security, and dissipated all the doubts which have hitherto restrained our actions. The battle fought by our forefathers for us, we must now fight for our children; and the sooner we fairly grapple with the fatal error, the easier will it be overcome.

NEW BUILDING ACT.

THE REPORT OF THE COMMITTEE APPOINTED BY THE SOCIETY OF MASTER CARPENTERS TO INVESTIGATE AND SUPERINTEND THE PROGRESS OF THE INTENDED NEW BUILDING ACT THROUGH PARLIAMENT.

YOUR Committee beg leave to report to the Society that, in accordance with their wishes, they have very carefully and deliberately perused and considered the several clauses and enactments contained in the proposed New Building Act, and they do not hesitate to pronounce it to be one of the most important measures in which the building interest at large has been interested for many years past; and they have much satisfaction in saying, that, in many of its parts, it is a great improvement upon the present Building Act, the 14th Geo. 3. cap. 78.

Your Committee state, that it is now upwards of two years since they entered upon the duty of watching the progress and considering the several building enactments proposed to the legislature during that period: in deliberating upon the present proposed bill, they have been actuated by a sincere desire to promote only the general good of the whole of the community: and when it is understood that it comprises within its limits, and controls by its powers, the domestic economy of between two and three millions of the inhabitants of the metropolitan district of this great empire, it must be obvious to all, that, as regards the objects embraced within its enactments, it is one of the most important Acts of Parliament that has occupied the attention of the building interests and the public generally for many years; and they therefore entreat the most serious consideration as to its probable effects upon all within its range.

Your Committee inform you that their attention has been called most particularly to a great evil in the old Building Act, namely, its extreme ambiguity: this has proved a source of much litigation and ill-feeling in a great number of instances. They have to recommend a strict regard to simplicity and plainness of language in the intended enactment, and have made several emendations therein where there appeared to be an ambiguity, or where there might arise a difference as to the construction or intention of its several provisions.

Your Committee state to the Society that, in the proposed act, a clause is inserted, which will prevent the use of PLACE bricks in any building: this prohibition they propose to modify; and, in order to prevent the improper use of shuffy, or soft bricks, they would advise that the words, instead of being good sound "WELL-BURNT" bricks it should read "GOOD SOUND" bricks, and that GOOD PLACE bricks should not be excluded; and they would also advise that no place bricks should be used at all externally, or in basement stories, at all events below the springing of the chimney arch; to prohibit the use of sound place bricks would operate most injuriously to the interests of the brickmaker, or must inevitably very greatly increase the price of stocks.

Your Committee, in discussing the clause that refers to the projecting or building shops or other erections in the front courts or front gardens of private houses, particularly in roads in the vicinity of town, while tenacious of detracting from the rights of the freeholder, cannot admit that one individual, in a respectable row of houses, should be allowed to cover his front garden to the annoyance and injury of the neighbourhood. They would propose, for the better definition of the line of street, that, in roads where the different rows of houses do not form one line, each row of houses should be considered the line of street. No encroachment on buildings of any description ought to be suffered in the fore-courts or garden-fronts abutting upon a public way.

Your Committee further state, that, in consequence of the proposed alteration in taking the rate of the houses, namely, by the height of the external walls instead of the superficial measure, they think it but proper that in some cases the party and external walls be increased in thickness *under the new act*.

Your Committee, however, cannot agree to recommend the several clauses which prohibit more than four floors, unless the walls are of a first-rate building. These clauses will prevent square attics in second and third and fourth-rate houses: for, under the proposed act, the floors are to be counted from the lowest or basement floor; under the old act, they were counted and all heights taken from the ground floor; it is true that an additional floor may be added by a kirb roof, the fore front not being above the prescribed height; but your committee submit that this mode of obtaining an additional floor is an evasion of, instead of a compliance with, the spirit of the act; and further, that this mode of construction by kirb roofs is not the soundest way in finishing the upper construction of any building, and ought not to be encouraged by the legislature.

Your Committee would wish most particularly to call your attention to the increased thickness proposed in the withs and backs and fronts of flues, and recommend your determined opposition to this proposition, especially as regards the backs and fronts of flues; it will add most considerably to the expenses, and cause unsightly projections into the several rooms, and also prevent, as at present, the flues being carried up in a two-brick party wall. Your committee have no hesitation in declaring this proposed addition as useless and uncalled for; the objection to the present thickness of the withs and the backs and front of flues might be met by a clause prohibiting any but hard sound stocks in the internal construction of such flues, worked smooth in the interior; and without pargeting, the whole or nearly the whole of a party wall to a third and fourth-rate house would, under this arrangement, have to be, from the foundation to the roof, no less than three bricks thick; and where the chimneys have to be built back to back, the whole thickness will not be less than five bricks thick, and will in some cases be even more than that.

Your Committee further submit that, as under the old act, so in the intended act, the usual recess or indent in party walls, for the pipes from internal upper water-closets, is not provided for; they have therefore recommended that provision should be made for this now universally called for accommodation.

Your Committee particularly call the attention of the Society to the clauses in the new bill, as to the construction and timbering of the several buildings to be built upon the commencement of the intended act; and to point out to the Society the impossibility of conforming in many instances to the schedule referred to: and further, that the limitation as to bearings and the consequent introduction of girders in every ceiling more than 15 feet square, will add most considerably to the expense of timbering, and at the same time, in almost every instance, very materially diminish the strength of the horizontal bearing of the floor above.

Your Committee further, and in connection with the preceding remark, beg to call your attention to the proposal to prohibit (almost all) timbers from being placed in party walls, and compelling trimmers, and trimming joists, girders, &c., to be placed upon shoes or corbels, a mode of construction objectionable in so many ways, that it is hoped that the promoters of the bill will at once withdraw the proposal.

Your Committee particularly call the attention of the Society to the enormous increase of the fees that will be chargeable upon every description of building; fees are not only more than doubled to the district surveyor, but it is proposed to appoint official referees in case of any difference between the builder and district surveyor, and in many other matters. These fees, already quite large enough, and quite satisfactory to the present district surveyors, will be so increased and so oppressive, that your Committee recommend your most determined opposition to the proposed scale. To increase these fees according to the present scale, will go a great way to defeat the benefit likely to accrue to the public by the recent reduction in the timber duties.

Your Committee do not object to the appointment of official referees, but that efficient persons may be appointed to that office, they recommend the erasure of the word ARCHITECT, being assured that there are many parties not being what is termed an architect, who would be much better qualified to carry out the details of a Building Act, but at the same time leaving it with the Home Secretary as to who shall be appointed. They also think, that if the official referees were paid by a salary, instead of by fees, it would be of much improvement, as preventing unnecessary references, at the same time the parties litigant paying certain fees, which might go in aid of the salaries.

Your Committee having endeavoured thus generally to bring the most material points in the bill under your notice, have pleasure in reporting, that in many respects the proposed bill is a great improvement upon the old Building Act, and have only to regret, that in the drawing up, Government did not avail themselves of PRACTICAL experience; they have only further to add, that they have annexed their observations in detail on the intended bill, and to which they beg to call the serious attention of the Society.

Signed by direction of the Committee,

May 17, 1843. H. BIERS, President.

To ascertain the Rate of Building.—Page 4, section 6, line 23. To prevent a difference of opinion between the district surveyor and the builder, as to which front is to be taken for the heights, it is recommended that the fore-front or principal front of the building be the one to be taken.

Page 4, sec. 6, line 24. The words "OR FIRST" ought to be taken out, as also the words "ANY ONE," and the words "the principal front" added, taking out the letter "s" in the word fronts.

Second-rate Building.—Page 4, sec. 8, line 33. The word "NOT" ought to be taken out, or second-rate houses will be prohibited from having more than four square stories, unless by that objectionable arrangement, a kirb roof or a room in the roof.

Official Referees.—Page 7, sec. 15, lines 2, 3. The words "being architect" ought to be taken out of this clause, leaving it to the Home Secretary to appoint any person having knowledge required; and here your Committee would suggest the propriety of a selection from persons of PRACTICAL experience.

Attached or Additional Buildings.—Page 7, sec. 16, line 20. The word "external" to be taken out.

Lines 22 and 25. Also, from the word "*but*" to the word "*completed*," leaving the WHOLE of the walls to additional buildings of the thickness according to the rate of such buildings.

Method of ascertaining the Rate.—Page 7, sec. 18, lines 40, 41. For ascertaining the heights for the purpose of determining the rate of the building, the principal, or fore front ought to be taken; it is therefore proposed to expunge the word "highest" and insert instead the word "principal," taking out the words "or side," "not being a party wall," as the side walls of a detached house will sometimes gable ten feet above the front.

Penalties.—Page 9, sec. 23, lines 24, 30, 31, 32. In this section the word "surveyor" is cut out, and the words "the poor of the parish" inserted instead, as it appears to your Committee that the surveyor ought not to be benefitted by his own negligence; this section will also be improved by the words "unless and to the end" being taken out.

Windows in Basement Story.—Page 9, sec. 24, line 37. The words "nine inches" ought to be taken out, if not, the window-backs in kitchens will be very low, if a thick lintel and a strong wall-plate are used over the window.

Heights of Rooms.—Page 10, sec. 25, line 3. The height of the basement story might with propriety be altered from eight feet to seven feet six inches, giving an opportunity of draining with a better current where the out-drainage will not permit quicker fall, and especially where buildings have front shops, more than one step to a shop entrance being objectionable.

Eighth Rate or Public Buildings to be re-surveyed after completion.—Page 10, sec. 28, lines 37, 38. To prevent ambiguity, and consequently difference of opinion between surveyor and builder, the word "SUCH" ought to be taken out, and the words "EIGHTH RATE" inserted. "TWENTY-ONE" days' notice to survey is much too long a notice; "SEVEN" has been substituted by your Committee.

Iron Doors in Party Walls to Warehouses, &c.—Page 12, sec. 32, lines 13, 15, 22. In this section the words from "and" to the word "wall" have been taken out, it being quite unnecessary to have so large a space between two iron doors as FOUR FEET; and the word "four" has been altered to the word "one," and it appears that limiting warehouses and workshops to thirty-five square feet may operate injuriously.

Cesspools in Streets and Alleys.—Page 14, sec. 31, lines 29, 30. The words from "and" with the whole of the thirtieth line, are taken out, as it appears to be useless to give the overseers the trouble of superintending a Building Act, when there are to be paid officers for such superintendence; this will apply to all the clauses of "Bill where &c."

Drains as to Superficial Measure.—Page 15, sec. 41, line 11. This section as it stands will do away with nine-inch barrel drains, which drains are of sufficient size for second, third, fourth, and all the other rates, with the exception of first and eighth rates. The word "EIGHTY" has been altered by your Committee to "SIXTY," thus making a nine-inch barrel drain available.

Private Drains.—Page 15, sec. 42. The observation as regards the overseers the same as preceding remark, page 14, sec. 38, line 29.

Scantlings and Construction as regards the timbering to Floors, Partitions, Roofs, &c.—Page 16, sec. 43, line 3; s. 44; p. 17; s. 45, line 1: and s. 46, line 26. It is recommended by your Committee, that the whole of the clauses regulating the scantlings and bearings of timbers be expunged, as leading to great difficulty, and promoting much litigation; similar clauses were formerly introduced in the 19th Charles 2, cap. 3, and also in the Act of Anne; but in all subsequent acts they were left out, being found impracticable in the carrying out in detail. The scantlings generally are objected to by your Committee, and the absurdity of enforcing a girder in every room more than fifteen feet square is so monstrous that your Committee cannot believe that any person of the smallest practical experience can have been consulted in this matter.

Girders and Bressummers.—Page 17, sec. 47, lines 27, 31. The words "girder or" throughout this section have been taken out, leaving the clause to the regulation of the bressummers only, and the words "tailed all" are also taken out, and the words "laid at least half" inserted instead; if this were not altered in this way, it would be a contradiction to subsequent parts of the act.

Heights of External Wall above Gutters.—Page 19, sec. 55, line 27. In this section, the words "six inches" are taken out; a foot above the highest part of the gutter being quite high enough.

Materials of External Walls.—Page 19, sec. 56, line 36. The words

well burnt are taken out, as good sound place, in proper proportions, have always been found to answer every purpose in all internal brickwork. If place bricks were altogether prohibited, it must create great loss to the brick maker, or a great advance must inevitably be made in the price of stocks.

Depths of Footing below Floors and Areas.—Page 18, sec. 49, line 14. With regard to the TOP of every footing being 12 inches below the surface of the lowest floor of the building, requires alteration, as it cannot be intended that on every foundation, especially if concreted, or other hard and dry substance, or where it may be required to have the part of the basement floor considerably lower than another, that the top of all the footings should be compelled to be below the lowest floor or area, in in which case there would be a very great waste of brickwork without answering any good purpose.

Upon requiring a decision by a Referee.—Page 21, sec. 60, line 32. Instead of the party requiring the reference having to pay the costs therein, and who may be the party aggrieved, it is proposed to strike out the words "requiring such reference," and inserting the words "in error."

Materials of Projections.—Page 23, sec. 61, line 1. Ten feet is considered a sufficient distance to prevent any danger from fire: the word "twenty" has been so altered.

Gathering over and corbelling of Chimney-stacks.—Page 23, sec. 65, lines 18, 19, 21. As corbelling or oversailing, both at the fronts and sides of chimney-stacks, if done carefully, has seldom been found to be so objectionable as to call for an entire prohibition, the words "either" and "or sides" have been taken out. The word "fifth" is altered to the "third;" if this were not so altered, it would prevent corbelling for dressing-room chimneys in the bedroom stories, and the word "third" altered to "second."

Materials and Thicknesses of Flues and Chimneys.—Page 23, sec. 66, line 28. The words "eight and a half" inches have been altered by your Committee to "four and a quarter," inasmuch as by permitting the intended thickness of eight and a half to remain part of the bill, a very large addition will be made in the outlay of brickwork, and those unsightly projections of the olden time will be again perpetrated in our new buildings; in no instance would the brickwork be of less thickness than two feet three inches, now only eighteen inches; sometimes even in single chimneys this thickness would be exceeded, and where the chimneys happen to be placed back to back, the mass of brickwork will be no less than four feet seven inches from the face of one breast to the face of the other.

Iron Chimney-bars.—Page 23, sec. 67, lines 37, 38, 39, 41. The words "iron chimney-bars" have been taken out of this section for the chimney openings of the upper stories, they increasing the expense without a corresponding advantage; and why *cradle* bars are enforced in the basement to chimneys, three feet ten inches opening, your Committee cannot understand; a strong chimney-bar is all that is required. The words "such bars to be built into the jambs at least four inches on each side" will therefore be unnecessary.

Flues above the roof.—Page 25, sec. 73, line 15. The word "nine" has been altered to "four and a quarter," being the thickness proposed by the alteration of sec. 66.

Chimney-pots.—Page 25, sec. 74, line 31. It appears by this section that a chimney-pot is to be fixed inside instead of upon the chimney-stack; this is no doubt a mistake, and should be rectified by introducing after the word "funnel" the words "being six feet in height."

Depth of Footings.—Page 26, sec. 79, line 37. As it appears that twelve inches above the top of the foundation would be more than required for any desirable purpose, the word "six" has been substituted.

Page 26, sec. 77, line 16. If this section remains as it is, it will prevent the fixing soot-doors, smoke jacks, &c.

Depth of Footings under floors.—Page 27, sec. 80, line 16. The above observation applies to this section.

Materials of Party Walls.—Page 27, sec. 82, line 40. The words "well burnt" are taken out, for the reason adduced in the observations upon sec. 56, &c.

Timbers, trimming Joists, Girders, &c., not to be let into party walls.—Page 28, sec. 82, lines 1 to 4. It is recommended to take out the whole of the words from the word "and" to the words "party wall," it being the most insecure manner of fixing a floor of joists that can well be imagined to prevent the timbers to be placed in a party wall, if kept at proper distance from the flues.

Party Walls next vacant Ground.—Page 28, sec. 84, line 28. If no consent can be obtained, the first builder ought to be permitted to build, upon the party withholding such consent, to an extent not exceeding nine inches, exclusive of the footing, which ought to be permitted, as for a first, second, or third rate house; if not, the first builder, through perhaps the obstinacy of a neighbour, would have to submit to the loss of a portion of his land, and which probably may be of great value.

Recesses in Party Walls as regards Indents.—Page 29, sec. 87, line 34, The words "metal pipes" are introduced after the word "corbels" to enable parties to insert, with the aid of an indent, such pipes as may be necessary for water closets in the interior and upper stories.

Page 30, sec. 89, line 21. The same observation applies to this section.

Page 30, sec. 90, line 31. Old sound party walls, built according to the present act, ought to be suffered to remain without having the thickness added to, unless the new buildings should be of a higher rate than that pulled down.

Party Fence Walls.—Page 34, sec. 95, line 12. The words "hereafter be built" ought to be inserted after the words "party fence."

Penalties for Alterations.—Page 49, sec. 115, lines 18, 19. After the word "builder" the words "or workman" ought to be inserted, as it often happens that, without the knowledge or consent of the master or builder, a workman will cut away a chimney-back or any other part of a party wall; and to render the section clear, in the line after the word "them" insert the words "as the case may be."

Surveyor may order Walls to be cut down to inspect.—Page 54, sec. 125, line 25. Your Committee have recommended an addition to this section, "that if, upon inspection, the works are found to be according to the act, the damage done and the reinstatement of the works be at the expense of the surveyor."

Fees to District Surveyor.—Page 55, sec. 129, line 41; p. 56, s. 129, line 8. The fees, according to the table in this section, are decidedly too high; it is true, that if the district surveyor has much additional duty, he ought to have remunerating fees; but if the sections as regard timbering are taken out, and which your Committee most strenuously advise should be insisted upon, the duties of the district surveyor will be but very little, if any, increased; it should also be recollected, that in the old act the fees were stated as maximum fees; in the new act, the fees are stated as positive, in many instances making the fees considerably above those permitted or awarded upon an appeal to a magistrate. Your Committee, fully appreciating the liberality which always characterizes the builders as a body, recommend the fees to be as set out in the old act, the amount to be positive. If the new fees are permitted to remain part of the bill, the public will derive little or no benefit from the late reduction in the timber duties, as what will be gained in duties will have to be paid in fees in the aggregate expenditure in the respective buildings.

Fees to Additional Buildings.—Page 56, sec. 129, lines 25 to 31, and line 45. The fees in this section for additional buildings ought to be qualified; all additions, if attached and built with the principal building, ought not to be chargeable, as it has almost invariably been considered that the fees to the principal building are remunerative for the appurtenances, such as kitchens, scullery, larders, wash-houses, &c., but not to stable-buildings, which ought to be considered chargeable additions, or any other erections not attached to the main building. The superintending the cutting away chimney-breasts, when a new building is about to be erected, ought to be considered as paid in the fees for such new building.

Fees to Official Referees.—Page 57, sec. 130, line 19. This section having been left blank for the fees to referees, the Committee have inserted such amount of fees therein as appears to them to be sufficiently remunerative, if fees are to be paid instead of salary; namely, for every survey made by them, and certifying therein, £2 2*s.* each. For any other certificate signed by them in pursuance of the directions of the act, 10*s.* 6*d.* each. For every award to be made in pursuance of the directions of this act, the sum of £2 2*s.* It will be also very desirable to have inserted a section, that where the parties can agree to the decision of a single referee, that his decision shall be binding, preventing, by this arrangement, a multiplication of fees and expenses.

Fees to Clerks of the Peace.—Page 57, sec. 131, line 27. The blank in this line we have filled up with the word "three-pence."

Limitation of Actions for Penalties.—To prevent ambiguity, after the word "such" insert the words "penalty or."

Fee for Certificate of Surveyor.—Page 59, sec. 138, line 44. Fee to the surveyor, £1 1*s.* for determining a disputed amount; but the committee cannot understand what costs are to be awarded to the referee in the matter, that too, by the surveyor.

Districts of the Referees.—Page 60, sec. 141, line 31. We think that the referees, or the Home Office, or some other authority, ought to define the limits of each respective district as regards the referees, and not put the public to the charge of a fee for the referees deciding which is the proper referee.

SEWERS, SURREY AND KENT.

REPORT OF MR. JOSEPH GWILT TO THE COMMISSIONERS OF SEWERS, FOR THE LIMITS EXTENDING FROM EAST MOULSEY, IN SURREY, TO THE RAVENSBOURNE, IN KENT, IN REPLY TO THE CHARGES OF THE SECRETARY TO THE POOR LAW COMMISSIONERS.

GENTLEMEN,

THE care of a large district of sewage, upwards of forty years since intrusted to my superintendence by the Commissioners of Sewers for the limits extending from East Moulsey to the Ravensbourne, must, unless I have slumbered during the period passed in your service, have enabled me to render some account of my stewardship, which called upon to do, I trust, that which I have now to submit will exhibit a statement proving that I have not been unworthy of the trust so long reposed in me.

The clamour attempted to be raised against some of the most important commissions in this metropolis, will, I am confident, be found upon investigation to derive no support from truth, inasmuch as the statements and Report of Mr. Edwin Chadwick, its author, whence the following observations are elicited, arise entirely from a one-sided inquiry, not the least anxiety having apparently been displayed by that gentleman to sift the value of the testimony used for the basis of his assertions.

The investigation of facts by the evidence of individuals, each skilful in his respective calling, is the most effectual method of arriving at truth; but the value of evidence so obtained is altogether of no utility, if the party superintending such investigation be himself incompetent to select that which is worthy from that which is worthless; and as there are few of us capable of knowing everything, so must in this case the dicta of the reporter be estimated, himself being incompetent, from inexperience and previous education, to draw just conclusions in matters of science, more especially if he have not taken the useful course generally adopted in this country, of suspending his judgment until he have had the patience to hear both sides of the question.

Personally I should have considered my time ill spent in refuting the wild assertions on the conduct of the sewage of the Metropolis contained in the recent "General Report on the Sanitary Condition of the Labouring Population of Great Britain," but as it has been thought proper that I should notice them, the task is undertaken by me without reluctance.

I have presumed thus to preface the observations on the Report in question to be offered to your notice. Its writer has ventured to impugn your conduct, as he has also by direct charge imputed ignorance and insufficiency to your officers. The importance, however, of praise or censure, depending on the person bestowing it, it may be better to turn from all consideration of the party alluded to, and proceed at once to a succinct account of the leading operations, which have under your sanction been undertaken in the parishes of Lambeth and Battersea, the special portions under your jurisdiction with which I have to deal.

My district, as you are well aware, consists of the whole of those parts of the parishes of Lambeth and Battersea, which are liable to the payment of sewer rates, and on occasions of importance my attention has been called to the outlying districts beyond them, towards the Ember branch of the Mole river. At the time I succeeded to the care of it, what was called Lambeth marsh, being the district bounded by the parish of Christchurch, by the Westminster and Blackfriar's roads, and by the Thames, was chiefly garden ground, with here and there a few dwellings on it. In the rainy season it was often covered with water, and in the winter several portions of it afforded the diversion of skating to thousands. The whole of what was then called St. George's Fields was drained by the outlet of this district, and these fields were bounded on the south-east by Newington causeway, on the west by St. George's road, on the north and north-west by the parishes of Lambeth and Christchurch, and on the north-east by Great Suffolk street, formerly called Dirty lane. Excepting some parts of the public roads, the natural surface of every portion of this district was and still is under high-water mark, in some places as much as five feet.

The ancient drainage of this tract of land was no other than an imperfect surface drainage, by means of an outlet whose sill was considerably above low-water mark, so that the period of the time of drainage, and the depth to which it could be drained, were restricted within very narrow limits. The mode of cleansing, keeping open, and repairing the banks of the sewers, was at that time extremely defective; under the act of Henry VIII., parties were presented to do certain works, at courts which were held only eight times in the year; but if neglect of the owners and occupiers to do the works presented occurred in any part, the works done by other parties on the line became altogether useless and ineffective. While, however, the lands were used for agricultural and horticultural purposes, much was not thought of the floods and inconveniences to which they were subjected. The population, as may be collected from the above, was thin, the principal portion of it being seated on a line of street running from the foot of Blackfriar's bridge, in a direction nearly parallel with the Thames, to the foot of Westminster bridge. Only a small relic of this street or road now remains, such being the south end of Pedlar's Acre.

During a period of some years after my appointment, some though little progress was made in improving the drainage; the Commissioners had not the power to make new sewers, and the inhabitants were supine until the Duchy of Cornwall, the See of Canterbury, and the City of London (all large land-owners in the district), on the expiration of the existing sub-interests in their several lands, began to entertain an opinion that, with the assistance of good drainage, their several properties might be relieved of the water with which they had been in a state of saturation for centuries, and thus become building ground, whereby their rents might be increased a hundred fold. To do this on extended and scientific principles, was therefore to them an object of the first importance, and their application to the Commission resulted from it.

The object in view could not, however, be effected without a power on the part of the Commissioners to make new sewers, which, as it has been observed, the Commission did not possess. Application was therefore, after much deliberation, made to the legislature to supply the deficient powers, and, strange to say, the bill for that purpose was so violently opposed by every one of the parishes whose purport it was to benefit, that, but for the strong and powerful interest possessed and exerted by the three principally interested parties above mentioned, it would not, at that period at least, have become law. The bill, however, passed, and the act of 1809 gave an impulse to the Commission which in no other mode could have been imparted to it. The commission lost no time in exerting the powers they had obtained. Here it may be as well to remark, that at that period the old London bridge was in existence, as it was indeed for many years afterwards; it acted, as is well known, in the nature of a pen to retard the free discharge of the waters of the Thames, and such being the case, the scientific men engaged in the consideration of the drainage of the level, considered it advisable to carry all lines of sewers as much as possible to openings below London bridge. Conflicting interests, however, at the time prevented the general adoption of that principle, and it is now perhaps fortunate that such was the case, as the rebuilding of the bridge, then not supposed to be so near its consummation, involved the removal of the dam.

One of the lowest levels under your commission, and, from its situation at that time, most in need of relief, was that which, as already described, formed the lower part of Lambeth, and was called the Prince's Meadow. The highest land therein was 3 feet 6 inches, and the lowest nearly 5 feet under high-water ordinary spring tides. The sill of the old outlet through which the waters passed off, called Dover Sluice, was 5 feet above low-water mark, from which, as the flow of the tide is 14 feet 6 inches opposite the sluice, it follows that from the surface of the lowest land to the sill of the sluice there was a fall of only 4 feet 6 inches, a height not sufficient wherein to construct an efficient sewer. This was the first case in which the Commissioners were requested to avail themselves of the new powers they had obtained, and to carry into execution the extended principle upon which their levels have since been drained; it moreover shows by its early execution that they lost no time in proceeding to carry out the new powers with which the legislature had intrusted them.

As soon as the 7th February, 1811, it was resolved to rebuild the sluice just mentioned, and it was thereon forthwith erected under my superintendence. The area of the old sluice was 7 feet, that of the new one 13 feet 5 inches, nearly therefore double the former. The sill of it was laid down nearly to low-water mark, very much at that time to the fear and against the remonstrances of persons even acquainted with what on the Thames were considered the true principles of drainage. I think I may refer to this work with some satisfaction, even at the risk of a charge of vanity being applied to me, inasmuch as the proof of its success is, that on land, then very frequently under water, there now stand all the new buildings comprising Upper Stamford Street, those of the Commercial Road, and of the several streets adjacent to them.

The great change thus introduced upon the level, extending its beneficial influence up into St. George's Fields, prepared the way for placing on it the fabric of Bethlehem Hospital and many large buildings, which otherwise could never have been prudently built within such a locality.

About this time the reports on the subject of draining the low lands were many and voluminous. Your late surveyor, Mr. Varnham, a gentleman of very great skill and integrity, and Mr. I'Anson, one of my present co-surveyors, being constantly engaged with me on the

subject. To these reports I beg to refer; I have recently reperused them preparatory to making this statement, and, notwithstanding the experience I have since acquired, I see no reason to change opinions then formed, or to shrink from their being submitted to the scrutiny of the most searching and scientific men in this or any other country.

On the 19th April, 1816, the Commissioners came to the resolution of rebuilding Arnold, the sluice next above Dover sluice already mentioned. The district drained by this sluice extends southward from the Dover district, occupying a very large tract of land, which comprises what is now York Road, and the land east, west, and south of it for a very considerable distance, the palace of the Archbishop of Canterbury being therein situated. At that time very few buildings, and those but of little importance, stood upon it. It was swampy, and not much better than the Dover Level before described. The sill of the old sluice was 4 feet 2 inches above low water ordinary springs; its area was literally only 3 feet 1 inch superficial. The new sluice was lowered 4 feet 2 inches, that is, to low-water mark, and the area of it was increased to 16 feet 7 inches superficial, being five times and a half greater than the old one.

New sewers, as in the Dover Level, being led up from this improved outlet, that which was unwholesome marsh ground has been covered with good buildings, as the west side of the Waterloo Bridge Road, the York Road, and the numerous branch streets therefrom, sufficiently testify. By it was also obtained the power of draining the Westminster Bridge Road and parts adjacent, which, from its first formation on the building of Westminster Bridge until a few years ago, had no drainage whatever, and that because the Commissioners of Sewers, as I have heretofore mentioned, had not the power to make new sewers. This sluice, by its increased dimensions, has afforded the means of receiving much more drainage than originally and naturally belonged to the level, and such has been gradually introduced upon it from year to year.

On the 23rd July, 1819, another most important work was committed to my charge, namely, the more effectual drainage of the tract (pretty large) of country called Battersea Fields. This, as has been hereinbefore stated, was in every rainy season for weeks under water, the consequence whereof was, great injury to the crops no less than to the health of the inhabitants on its borders. The level of the old sluice was 2 feet above low-water ordinary springs, and its area only 12 feet 4 inches superficial. The general surface of the land in this district is from 7 to 10 feet under high-water mark, and it is now brought into such a state as to be capable of becoming, and it doubtless within a few years will become, building ground. Indeed, since its drainage, a church and many other buildings have been erected on it, which heretofore could not have been prudently done.

This new drainage was effected by a pair of folding gates pointed to the river, and capable of discharging a column of water twelve times greater than that which passed through the old sluice. The sill of these gates was lowered 2 feet, that is, down to low-water mark. Under what class of scientific and practical operations Mr. Edwin Chadwick may rank this improvement I am not aware, and not being ambitious to assume the title of Civil Engineer, I am quite unconcerned on that point. All that I am desirous of bringing to your notice is, that you executed a work which has, as is consistent with the knowledge of every one, prevented the waters lying on the lands even for a single day, and has moreover extirpated disease, which in the neighbourhood was previously extremely prevalent.

The last communication with the Thames within my district necessary to be brought under your review, is that just above Vauxhall bridge, known by the name of Effra river, or Vauxhall Creek Sewer. This, from its situation, partakes more of the nature of a river than of a sewer, and falls into the Thames without protecting gates or sluice at the level of low-water itself; for, being the outlet of the drainage of the high lands about Brixton and Dulwich, its bed, very soon after leaving the river, is out of reach of high-water mark, and therefore (though of much importance) its natural formation renders in that respect unnecessary the assistance from your Commission which is absolutely requisite on the low lands. Yet hereto the care of the Commission has been constantly and zealously directed; and, from the attention bestowed upon it, the proprietors of all the lands of North Brixton and its neighbourhood, east and west, have been enabled to convert them into building ground of very profitable description, and to realize rents which half a century since could never have been anticipated. The very road on whose sides these rents have been realized was called the Brixton Washway, the road itself being in rainy seasons actually the drain of the country.

Thus far as regards the works of the Commission with respect to the principal outlets within my district, without attention to which, and the application of science, no system of inward drainage could be effected in low lands. They call for great skill, and an acquaintance with the principles of civil engineering in their construction. How far they have answered their ends the public have long since been able to judge. I now, therefore, close this portion of my Report to you by observing, that since the year 1809 no less than 46,874 feet, nearly nine miles, of new arched sewers have been constructed upon levels corresponding to the improved outlets of my district, by which a vast superficies of land has been rendered dry and wholesome. I do not pretend to say that nothing remains to be done, on the contrary, much is still required, which, with funds at hand, would no doubt be immediately undertaken.

I must here remind you of one most important feature in respect of the large tract of country under your jurisdiction, one which in most points makes it dissimilar to the greater part of the districts under Commissioners on the northern bank of the Thames. That under your care, it must be recollected, is almost entirely below the level of high-water mark, whilst on the other side of the river the Commissioners have to deal mostly with lands whose acclivity from the great drain of the country soon places them out of the reach of its power on high tides. A portion of the Westminster Commission and some others are under circumstances similar to your own. Every one acquainted with this matter, as you well are, will be aware, how much more easily lands may be dealt with which are out of the reach of high water than those whose sewers lie for hours every tide with accumulating back waters, susceptible of being discharged only when the tides leaves the mouths by which they are emptied. The object of the Reporter, Mr. Edwin Chadwick, seems to be the establishment of a central board for the control of all sewage. That this could be satisfactorily accomplished, with certain fixed principles applicable to all cases and situations, is not very probable. The varieties of different levels must each be studied, and treated on principles accordant with their several natures. It will be remembered that in the year 1834 an investigation with the above view was entered on by a Committee of the House of Commons; after many meetings that Committee closed their Report with the following sentence:—

"They see so many objections to a Central Board superseding in part or altogether the local trusts, a change which would be most unpalatable to the inhabitants of the respective districts, that they cannot recommend it as desirable, until at all events the effect of the changes suggested in the present Report, should the House think proper to approve of them, shall have been fairly tried."

I could without difficulty extend this Report by the recapitulation of the improved method of conducting the ordinary works in my district, but that is well known to you, and I must now therefore proceed to notice some of the unwarranted assertions of Mr. Edwin Chadwick relative to the Commissioners of Sewers in the metropolis; they would have been scarcely worthy of notice but for the great circulation they have acquired by their gratuitous distribution.

In page 54 of his Report Mr. Chadwick says, "The sewerage (*sic*) of the metropolis, though it is a frequent subject of boast to those who have not examined its operations or effects, will be found to be a vast monument of defective administration, of lavish expenditure, and extremely defective execution." A captivating and beautifully turned period, without an atom of truth in its composition, nor the smallest foundation in fact. My assertion is as good as that of Mr. Edwin Chadwick, and if there be any truth in the maxim "cuique in suâ arte credendum," I am entitled, perhaps, to a little more trust than is to be reposed in that gentleman. But his reason for the assertion in the succeeding period is curious, though not so magniloquently expressed, it is, "The general defect of these works is, they are so constructed as to accumulate deposits within them, that the accumulations remain for years, and are at last removed by hand labour and cartage." Speaking of the district under my care, the assertion of the deposits remaining in the sewers for years is untrue, and I believe it will be found to be so in the other districts of your Commission. There is, however, no necessity in this matter to depend on my bare assertion; the quarterly accounts of the casters, and the documents connected therewith, will prove it to be unfounded. I, of course, know not how the assertion may affect other Commissions, but, sweeping as it is, it will, I have no doubt, with respect to them turn out equally unfounded.

In p. 55 of the Report, Mr. Edwin Chadwick introduces to the favourable notice of the public a Mr. Roe, a civil engineer, "who," as he says, "much to the honour of the Holborn and Finsbury district of sewers, has been appointed to the care of their sewers, and is perhaps the only officer having the experience and qualifications of a civil engineer;" and then he gives Mr. Roe's opinion on the subject of flat-bottomed sewers, which, if he and Mr. Roe knew anything about the matter, they would have been aware had been many years discontinued, and never universally used, nor at all indeed in my district. I shall hereafter have something to observe on Mr. Roe's alleged invention of flushing sewers, to the discovery of which he has no more claim than one of his own subordinates; but for a moment I must stop to observe, how restricted Mr. Chadwick's knowledge must

be of those who are civil engineers, and where employed; thus the justly esteemed Mr. James Walker is, or till very lately was, surveyor of the important metropolitan district of Poplar marsh. The Reporter's slip, however, is very excusable; though a man may write on every subject, it would be very unreasonable to expect him to be versed in all. I much regret to introduce here the name of Mr. Roe, but to Mr. Chadwick he is indebted for my notice of him; I doubt not he is an able and respectable man, though his name is altogether unknown to that part of the scientific world with which I am in the habit of associating. I must, however, deal with him here, as laying claim to an invention to which your own surveyors can prove a better title than himself, namely, the flushing principle.

The flushing principle, as it is denominated by Mr. Roe, is in other words the use of a head of water, which, on being freed, shall, by its momentum, have the power of washing down at once into the Thames or main drain the accumulated silt of the sewers. Now this very principle has, beyond the memory of the present generation, been actively employed on the Great Duffield sewer of the extended district under your charge, for washing out and keeping wholesome the tract of land on each side of it, from the archbishop's palace at Lambeth to its mouth, near Salisbury stairs, at Bermondsey. It is a subject upon which, on the 27th July, 1810, a report was submitted to you by the late Mr. Varnham, Mr. l'Anson, and myself. The principle has always been partially used in your districts, where necessary and applicable, but the great modern improvement in your drainage renders its use less frequent now than formerly. Mr. Donaldson has truly said in his Report to the Westminster Commissioners, (*Times*, Dec. 26, 1842) that "adopted as a general system, it is one of the worst expedients in drainage, and indeed its use is justifiable only where the fall of the bed of a sewer is from the nature of the country so sluggish, that some stimulus must be applied in the nature of an impelling force, to carry off its own deposits unloaded by road scrapings and other extraneous matter. Wherever the force is expended, the silt is augmented, and the obstruction is only removed to another place.

Mr. Roe's four years' experience, when extended to ten times that number of years, which have been passed by me in considering schemes of drainage in low lands, will perhaps bring him to the conclusion at which I have arrived. In p. 56 of the Reporter, Mr. Roe is asked, "What are the chief effects of the piecemeal town drainage, without reference to extended levels?" Answer,—"Chiefly that when new lines of houses are built, and require new sewers, either the old sewers must be taken up and re-constructed to adjust them to a new and effective sewerage, or the new sewers, if they are adjusted to the old ones, are deficient in fall, and they have greater deposits." The answer is quite suitable to the question. He makes the giants first, and then he kills them. We have no clue to the locus of the piecemeal drainage, but the picture is drawn with skill. Nine persons out of ten would deduce from it that Commissioners of Sewers generally have to do their work twice over, and that the sewers they first lay down are thereafter usually found unfit for their purpose. Now the fact is, that all the ancient sewage of the metropolis, set out centuries ago, was constructed to serve very restricted limits, and moreover was calculated for little beyond a surface drainage. The extension of new buildings of late years, has demanded a totally different species of operation from that which was formerly sufficient. In the parish of Lambeth, since the first lowering of the outlets (after the act of 1809), which converted it into building land, no alteration or remaking of any kind has on any occasion been found necessary. In p. 57, Mr. Roe is made to say, that "the prevalent practice is to join sewers at angles—frequently at right angles." To this, as applicable to the sewers in my district, I must give an unqualified contradiction. I can hardly suppose Mr. Roe's assertion to have been made but from misinformation. The curves at the junction of sewers in the Lambeth district are mostly made with radii much longer than 20 feet, the limit of practice in the Holborn and Finsbury district. (See p. 376.)

In p. 58, Mr. Oldfield, an experienced builder in the wealthy districts of the metropolis, is made to speak of exemplifications of the mischiefs resulting from the defective modes of opening sub-drains or communications, even from houses of the first class, into the main drains. Now, with much respect for builders, I should as soon think (as a reverend gentleman speaking on another subject has said), of consulting a committee of horses on the most approved forms of curbs and bits to restrain them, as of taking their opinions, however respectable they may be, as to the mode of controlling them in opening into the main sewers. But the Reporter, whose report is so ill arranged that it is difficult to connect the different parts of it, no one subject being finished before another is started, merely appends to a note on the introduction of Mr. Oldfield, "see post." After turning over the leaves of the Report for a considerable time, to see where this *post* was, I found at last, in page 320, that this same Mr. Oldfield says, that "they (the drains) should be done entirely by the persons in charge of sewers, or under the control of officers of competent skill," &c., and this, as it happens, is the very course adopted by you long before Mr. Oldfield and Mr. Chadwick became known to the world.

In page 317, Mr. Chadwick favours the public through the medium of a gentleman "who is himself a surveyor of extensive practice," with the following qualification of what surveyors of sewers ought to be: "I would observe that very few of them are properly qualified by education, or otherwise, to perform the important duties intrusted to them in an effective and proper manner. A man, to be a good surveyor of sewers, should be a practical civil engineer, in which service is comprehended levelling in all its branches, and other matters requisite and necessary in the construction of drains and sewers," &c. Who this surveyor of extensive practice is, I am at a loss to conjecture, but of this I am certain, that he was a person of no ordinary acquirements, who discovered that levelling had more than a stem without any branches. If he be not incomprehensibly obtuse, I would venture to promise him and Mr. Edwin Chadwick, supposing both equally qualified, to perfect them in the principles and practice of this abstruse science, within little more than a week from entering themselves as my pupils. In the other matters requisite, I might not perhaps find either the one or the other very apt scholars. Whilst, however, on the subject of levelling, it may be proper to state, that so alive has the Commission always been to the indispensible necessity of a due adjustment of the several levels to the drainage of your district, that in the year 1811, only two years after the passing of the act above alluded to, your surveyors were directed to carry up chains of levels from the outlet of every sewer within your jurisdiction. The profiles so directed to be made and verified by themselves (Mr. Varnham being now deceased), still exist, to disprove Mr. Chadwick's insinuations as to the qualifications of the surveyors, at least for levelling, as does moreover the execution by them, some years afterwards, of a very curious document in your possession, namely, an elevation of the southern bank of the Thames from Battersea to Deptford, in order to check the overflow of the Thames at high tides over the defective or lower banks of the river itself, a pretty convincing proof of the zeal with which he Commission has discharged its functions, and at the same time a valuable engineering document.

But I fear the length of this Report may exhaust your attention, seeing that the charges against you and your officers are utterly groundless; I must therefore compress my closing remarks within as narrow a compass as a due notice of the Reporter's assertions will allow: these will relate to the forms adopted for the sewers in my district, which are similar to those employed in the districts of Mr. l'Anson and Mr. Newman, your other surveyors.

In page 378 of the Report, we have the evidence of Mr. Roe on this subject, we are there indulged: in fig. 1 and 2, with his *beau-ideal* of the forms of sewers, both of them in section resembling an egg standing on the part which Columbus broke, and inverting the usual practice of building and engineering, by diminishing the base, and increasing the superstructure bearing on it. I am ashamed to say, that about the month of April, 1801 (I was then a very young man), I constructed a sewer leading from the Arnold outlet, at what was then called Cuper's bridge, so nearly of the shape of the figure 1, that upon comparing them a practised eye would not perceive a difference. Independent of the objection of its want of a broad bearing, it was found to be so extremely inconvenient for the castors to work in, from the sharpness of the curve, whereon in working they had to stand, that I was not at all displeased when the works of Waterloo bridge, many years afterwards, rendered it necessary to change the line of sewage to meet the altered direction of the streets, so that, fortunately for my reputation, it no longer exists, and if I am left to the exercise of my discretion, the oviform sewer will never again be used by me. I should incline more to a good opinion of Mr. Roe's egg-forms, for I am quite content that he have the credit (if he so consider it,) due to their introduction, if he would consent to turn his figures upside down. There are, however, other most important and scientific objections whereto they are liable, upon which, in this general statement, it is unnecessary to enter.

As great stress has been laid on the alleged impropriety of making sewers with upright sides, it is proper that I should here exhibit the form which, for the last thirty years, has been adopted for the main sewers in my district, in order that you may rightly appreciate the probability of pressure on the sides forcing them in (see p. 374), and at the same time that there may be exhibited to you what a small length of upright sides is employed, whence it may be judged what additional strength in resisting pressure the whole combination would acquire. (Ibid).

Take the large sized sewer of 5 feet by 4 feet, as in the diagram below. This nearly approaches a barrel form, and from inspection

it will be seen, that the 12 inches of upright work from A to B, from which the upper arch springs, will be prevented being forced in by the pressure of the earth lying against it, because of the horizontal thrust of both the upper and the under arches; and in an extensive practice I have invariably found this to be the case. You well know that many thousand feet of this species of sewer have been executed, varying only in dimensions, and that without a failure, though it is well known that in the districts on the south side of the Thames, the badness occasionally of the soils in which works have been performed has surrounded their execution with every species of difficulty. Long experience has convinced me, that the form adopted for the district is not only the easiest and cheapest in execution, but that it is much more likely to be built sound than a continued radiation of joints would permit; and beyond this, it is a much more convenient form for those that execute the work than any that can be suggested. It is worthy of observation, that the versed sine of an arc of 2 feet radius, the chord being 12 inches, would not amount to more than to 1 inch, or thereabouts so that the capacity of the sewer would not be increased more than 2 inches superficial. Mr. Donaldson, in his Report before alluded to, has well observed, that "all circular work constructed of brick can only be formed by making the joints more open at the extrados than at the intrados, for the square shape of the brick does not lend itself to other than rectangular construction. The fact is, that in all brick arches, the approximation to wedge-like forms in the voussoirs (pieces of which an arch consists) is obtained by means of a greater thickness of mortar joint at the back, which when once set, if the mortar be good, becomes as hard, indeed harder, than the bricks themselves. In some cases, as, for example, the peculiar one of the Brixton Washway, the segmental curve of the invert is eliminated because of other considerations from a level set of footings, but in most instances the nature of the soils does not require such precautions, neither does the work of ordinary sewers absolutely demand it. To sum up then the clamour about curved sides as respects the district in which I act, I have no hesitation in pronouncing it an useless and impracticable (using that epithet in its ordinary sense) refinement, which, adopted, would not secure an additional day's duration to any sewer in which it may be employed.

I have now, I believe, touched on the leading points applicable to my district, alluded to in Mr. Edwin Chadwick's Report, excepting only the generation and escape of noxious gases and effluvia from gully holes communicating with the sewers. This is not an inconvenience which has yet been the subject of complaint to you in my district; and as I have reason to believe it will be alluded to in the Reports of my co-surveyors, whose districts are more densely populated, I have left it to them to report more particularly on that subject. The accusations and assertions of Mr. Chadwick affecting the integrity of the Commissioners, and the mode in which their operations have been conducted, if they need an answer, will doubtless receive one from yourselves. As respects the ability of the officers to whom you have intrusted your works, I hope I may without vanity assert their scientific reputation to be at least quite as extensive as that of Mr. Roe, whom Mr. Chadwick has deemed worthy a niche in his Temple of Fame.

From the extremely defective arrangement of the Report which is the subject of the preceding observations, it is possible I may have omitted to notice some points which ought perhaps to have been alluded to, but I am inclined to think that they cannot be of much importance; if such, however, be the case, I have the consolation of knowing that they will meet the attention and correction of those able gentlemen with whom I have long been associated as one of your surveyors. I have the honour to be, Gentlemen,

Your obedient and faithful servant,
JOSEPH GWILT.

20, *Abingdon Street, 28th Feb.*, 1843.

To the Committee for General Purposes of the Commissioners of Sewers for the limits extending from East Moulsey in Surrey to the Ravensbourne in Kent.

AN ACCOUNT OF THE RECLAIMING AND DRAINING OF LAND IN THE BEDFORD LEVEL, COMMONLY CALLED THE GREAT LEVEL OF THE FENS.

BY HARDY WELLS, C. E. AND SURVEYOR.

(*Continued from page* 148.)

About two years after Lieutenant Page had delivered his Report to the Commissioners, Lord Townshend, who was then an active member of the Corporation, and took great interest in the attempts that were being made to drain the Fens, engaged Mr. Creassy to make a survey. But at this time the country took little interest in the subject, and every great scheme was consequently only partially considered, and then hastily abandoned. The Report, however, is an important document in the engineering history of the Fens, and, although it contains some fallacious opinions which will be at once detected by persons who are acquainted with the art of drainage, it also embodies some great principles well worthy of attention.

The Report and Opinion of James Creassy, respecting the Drainage of the Middle and South Levels of the Fens, called the Bedford Level.

At the request of the Right Honourable Lord Viscount Townshend, Master General of His Majesty's Ordnance, I have taken a view of the Fens and low grounds in the Middle and South Levels, and also of Lynn Harbour, and am clearly of opinion, that the most effectual way to drain those extensive and valuable tracts of land now under consideration, is by adopting the principles hereinafter mentioned.

I am of opinion, that the attempting to run the waters off the low lands in the same canal or river with those that flow from the high country in time of floods, is inconsistent with and contrary both to reason and experience, which I flatter myself I shall be able to prove in the course of this treatise. The great rivers, brooks, and becks, which bring down the waters from an extensive high country, are much elevated above the plain to be drained, and consequently are discharged with great velocity at their first entrance into the Fens, after heavy rains, or the melting of great snows, and finding there but little fall for many miles together, the current becomes languid and slow, till these flood waters rise much above the surface of the lands to be drained, and therefore it becomes utterly impracticable to drain those lands into such rivers, immediately where such lands abut thereupon, during the time the floods are coming down, except such lands as lie very near the outfall, where the inclined plane formed by the running of the highland waters falls below the surface of the land, and it is well known that these flood waters are in the forementioned state for many months every year. The water in the river Ouse, and several other rivers, were considerably higher than the surface of many thousand acres of low land at the time I viewed the Levels, which was in the middle of July, particularly near the high country, and therefore those lands that be remote from the outfalls are too high up those rivers, and as such are over-rode by the highland waters. All attempts hitherto made to perform a general drainage have proved abortive, because plans have been pursued that were founded upon fallacious principles.

For though I admit the widening and deepening of rivers is an advantage to the draining the country, it being evident that a river of one hundred feet wide and a given depth will run double the quantity of water in the same time that one of fifty feet wide and the same depth will do, nay, something more, as the resistance on the sides will be less in proportion, but still the waters must rise to the same height at the upper end of the same rivers, before they will run with equal velocity, allowing for the before-mentioned resistance.

I shall here consider all running waters to form an inclined plane, though, mathematically speaking, they form an inclined curve, which has one end nearer the centre of the earth than the other, and the velocity of all running waters will be in proportion to the declivity of the surface they run upon, and therefore it must appear demonstrative that two or more rivers may be made parallel to each other, and yet have different falls in a given distance, and still these rivers may be united, and the waters run together at a given point. But to demonstrate this more plainly, let A B represent the horizontal or level line from the top end of the highest river, and B C the fall of twenty feet; then if the bottom of the river be made with a regular declivity, the surface of the water when running, will form the inclined plane A C. Then suppose another river made parallel to this, whose fall in the same distance is only ten feet, and that if the bottom thereof be made with a regular declivity, the surface of the water when running therein will form the inclined plane D C, and the waters of the lower river will unite with those of the higher, and both run together at the point C, though it would be impossible to run the waters out of the lower river into the higher, at the upper end A D, because the surface of the one is higher than the other by ten feet, nor will it run into the river any where, till it gets below the point F. It is equally plain, that if the waters in the upper river are running, and those in the lower are stopt at the lower end, and have no communication with each other till they arrive at the point E, which is level with the upper end D, they will rise to that level, and have a fall of ten feet from E to C.

From the above-mentioned propositions, it is evident that the waters coming from the high country (which I conceive to be nineteen parts

out of twenty of all the waters that drown the low lands in question), may, if they are confined in their courses by strong banks, be higher by several feet than the low lands adjoining, and yet those lands may be well drained, by having drains cut parallel to the said rivers, and carrying the low land waters down to a lower part of the outfall, without letting them communicate at all with those coming from the high lands, till the inclined plane formed by the running of the high land waters is lower than the low lands to be drained.

The plan that I would recommend for the more effectual draining of the above-mentioned part of the country, is first to build two sluices a little above Lynn, one on each side the river Ouse, to be each sixty feet clear water way, and the floors thereof to be five foot below low-water mark at Lynn, with pointing doors to stem the tides, and to be erected at such points of the river, as that both ebb and flood may pass close by their mouths, in order to scour away the silt, &c., and keep the passage clean.

I recommend a drain to be cut from the sluice of the west side parallel to the river Ouse, up to Salter's Lode, eighty feet at the top, and to slope a foot and a half on each side for every foot in depth, and to be made as deep at the lower end as the floor of the sluice, and to lay half the earth arising therefrom on the bank of the Ouse, and the remainder on the opposite side the drain in bank fashion, and to cut a drain from the sluice on the east side, in as straight a direction as the nature of the country will admit of, to the lower end of St. John's Eau, and to scour out the said St. John's Eau, and cut a drain from the upper of the same to Stoke river, parallel to the Ouse, of the dimensions, and in the same manner as the drain recommended on the west side.

I also recommend a drain to be cut parallel to the river Ouse, on the east side, from the said Stoke river to the Grant or Cambridge river, and from hence up the side of the said river to the high lands, forty feet wide at top, and to slope a foot and a half on each side for every foot in depth, and to seven feet deep at the upper end, and the bottom to form a regular declivity from thence to the sea sluice recommended to be built near Lynn, all the earth arising from the said drain to be applied in heightening and straightening the banks of the Ouse and Grant.

I likewise recommend the Stoke, Brandon, Mildenhall, and Soham rivers, to be strongly embanked up to the high lands by cutting a parallel drain on each side the said several rivers, of such dimensions as will produce earth sufficient to make the banks of equal height to the bank proposed to be made on each side the Ouse, and of sufficient strength to confine all the water running down from the high country in their several channels down to the Ouse. I also recommend sunken tunnels to be laid under the Stoke, Brandon, Mildenhall, and Soham rivers, in order to discharge the sockage and downfall waters from off the low lands and Fens, lying on the east side of the Ouse, so that those waters may have a free passage down the side drain proposed to be cut parallel to the river Ouse to the sea sluice near Lynn, without communicating at all with any of the high land waters.

On the west side of the Ouse, from Denver Sluice to a little above where the Brandon river falls in, the land adjoining the Ouse bank is considerably higher than the rest of the Fens, and several houses, barns, &c., built thereon; I therefore recommend the Ouse bank to be repaired along that part with earth taken from the forelands of the river; it will take about five floors in every twenty feet in length, reckoning four hundred cube feet to a floor; and from thence I recommend a drain to be cut parallel to the rivers Ouse and Grant up to the high lands on the west side, in the same manner and of the same dimensions as that proposed to be cut on the east side, and to dispose of the earth in repairing the banks of the said Ouse and Grant. The next thing I recommend, is, to cut a drain on the east side the Hundred Foot river, and parallel thereto, from Denver sluice to the upper end at Erith, thirty feet broad at the top, the same slope on the sides as before recommended, seven feet deep at the upper end; the bottom to be made with a regular declivity, and the earth to be applied in heightening and strengthening the bank of the Hundred Foot river.

N.B. There must be a drain from the lowest ends of the drain proposed to be made on the west side the Ouse, to communicate with this last mentioned drain, and therefore it should be made wider from the lower ends to the junction.

I likewise recommend the side drain from the upper end of the Hundred Foot river, up the east side of the Ouse to the high lands, and apply the earth in repairing the Ouse banks.

I recommend a sunken tunnel to be laid under the river Ouse, immediately above Denver sluice, so that all the sockage and downfall waters of the Fens lying between the Hundred Foot river and the Ouse, may pass freely down the side drain to Lynn, without communicating with the high land waters. I also recommend a strong bank to be made on the west side the Hundred Foot river, and taking down the West Foreland, fifty feet wide, and as deep as the workmen can get at low-water mark, and to lay the said bank at least a hundred feet from the prick of the spade, to give an ample passage to the Huntingdon waters, and then the Old Bedford will serve as a drain to discharge the sockage and downfall waters of the Fens.

The next thing I recommend is, to collect all the high land waters that can possibly be collected, by cutting catchwater drains along the skirt of the high lands, but high enough up to discharge part of the waters in one embanked river, and part into another, so that no high land waters be suffered to flow into the Fens and low grounds to be drained. Though the distance along the skirt of the hills is very considerable, I apprehend it will not be attended with so much expense as some may imagine, as the drains require to be but of small dimensions, and as such will be all cash work, which is much cheaper than borrowing.

I recommend the river Nene to be widened and deepened from Salter's Lode sluice to Popham's Eau, and to widen and deepen the said Popham's Eau to its junction at its upper end with the said Nene, and to widen and deepen the Nene from thence to March, so that the said river Nene and Popham's Eau may be fifty feet wide at the top, and the same slope on the sides as the drains before mentioned, and to be eight feet deeper at a medium than the low lands to be drained, and its bottom to be made with a regular declivity, and to communicate at the lowest end with the drain proposed to be cut by the east side of the Ouse, so that the waters may be carried down and discharged at Lynn, along with those of the Old Bedford; and from March I recommend the Nene to be widened and deepened to its junction with Whittlesey dyke, so that it may be forty feet broad at the top, and seven feet deeper than the adjoining low lands at a medium.

These are the great works which I conceive necessary towards completing a general drainage of this extensive and fruitful country. There are several other works of an inferior kind needful, but I look upon those as secondary, and of a local and private nature.

I shall now proceed to make some remarks upon the circumstances and advantages that will of course attend the adopting the plan here recommended. In the first place I am satisfied that low-water mark at Lynn is considerably lower than the low lands to be drained, and it is self-evident that the surface of the water at that point must be lower than any part of the river upwards, during the time of ebb, otherwise the water in the respective rivers would not run down to Lynn. It is equally plain that the surface of the waters in the several rivers gradually rises all the way from Lynn up to the high lands. Even when I viewed the Fens in July, the surface of the water in the Ouse &c., was above the surface of the lands to be drained at the Mildenhall river, and so continued higher above the lands till I came to the high country, and they must be much more so in the time of floods.

It therefore becomes impossible for the low lands to drain into these rivers, but as I have lands lie much higher than low-water mark at Lynn, it is evident they will drain there if they have separate channels to convey their waters, independent of those coming from the high country, as they will run there at all seasons of the year, notwithstanding the floods in the embanked river may rise considerably higher than the surface of those low lands, especially such as lie at a distance from the outfall.

That Lynn is a spacious outfall, capable of receiving and discharging these united waters, is indisputably true, and I am well satisfied, that if all the flood waters coming from the high lands were properly embanked and confined in their channels, they will come down quicker, and consequently act with more force in driving out the silt and matter brought in by the tides, and those, united with the Fen waters near Lynn, will scour out and keep open a deep channel to sea, which is but a short distance from Lynn harbour; besides, the Denver sluice in this case will become useless, and as such may be removed, and the materials applied to other uses, and let the indraught of the tides flow up the Ouse as it formerly did, and then its refuse, together with the flood waters in the embanked rivers, will come with such force past the mouths of the sluices, as will greatly improve the navigation and harbour of Lynn.

The next thing is, I am persuaded the works here recommended will be executed at less expense than those of scouring and widening, deepening and embanking the several rivers that bring down the flood waters, if the banks of those rivers are made equally substantial; for the vast expense of making dams across these spacious rivers running the waters into other courses, or over the Fens during the time the works are executing, and the immense expense of milling the water out of such spacious rivers before the workmen can begin to work, and during its continuance, will in a great measure be saved by adopting the plan here recommended; and I do declare it as my opinion, that it is not practicable to dig the present river sufficiently capacious to reduce the flood waters below the surface of the lowlands to be drained, even in ordinary seasons, at an expense that can be borne by the united interests of the lands and commerce; and if it was practicable, no one, I believe, will be bold enough to affirm that the tides would not bring in the sands again, and soon cause the same obstructions that are now complained of; and, it must be allowed, if the waters were so lowered in the several rivers as to give all the lands an opportunity to drain

into the same, there would be so much less fall to Lynn; as the surface of the waters was reduced at the upper end, and of course the flood waters would discharge themselves with less force, and have less power to drive out the sands and other matter brought in by the tides, and therefore it is presumed the sands would increase in proportion, till they would force back the waters and cause them to rise to their usual height.

On the other hand, as flood waters come from a country much elevated above the plain to be drained, and even much above the flow of the highest tide, it is evident that all such waters may be conveyed between strong banks to overtop the tides at high-water mark, if necessary. But the banks in all these levels are weakest where they should be the strongest, viz., near the high country, where the water, according to the nature of things, must rise the highest. Every person must see that the more these flood waters are confined, and the higher they are embanked, the greater will be the velocity, and the greater will be the effect in driving away the silt and other matter brought in by the tides on the one hand, and the soil brought down by these high land rivers will be kept in motion and carried to the sea on the other. And this is a circumstance of no small importance, as it is well known that the tides bring in and leave such vast quantities of silt in dry seasons, which choaks up the rivers so much, that, before the floods (when they come) can clean out this silt and make a passage to sea, the whole country is deluged.

The next thing is, the country will be rendered dry, as the works advance upwards, and, as such, will become cultivated and improved, and the inhabitants will be satisfied of the utility of the undertaking, and prosecute it with more vigour.

It is also to be considered, that almost all those vast sums that are now spent to very little purpose in partial drainage by engine and private partial embankments, will be saved, which, of all other methods of drainage, is not only the most expensive, but in the end never fails to bring destruction on a country where such a vast extent of land depends upon one general drainage; and such engines and partial drainage should never be made use of but to drain lakes or meers where there is no fall to sea, when a general drainage can be executed. The next thing is, the navigation and trade of Lynn, &c. will be prodigiously increased by having so many more thousand acres of land cultivated and inhabited, that now is, comparatively speaking, a lost undone country, and by having more commodious haling bays up the sides of the several embanked rivers, will cause greater dispatch in business. Boston is now become a flourishing place of trade and commerce, since the drainage and cultivation of the Fens adjoining, and the same causes will produce the same effect at Lynn, or any other place.

The next advange is, that by adopting the above plan, leading drains will be cut with little more expense than what would be required for embanking the rivers, which was the other practicable method at any expense that could be borne; then there would not want leading drains to carry the Fen waters into the rivers, beside a great number of sluices, tunnels, &c., so that the plan here recommended will be doing two works at the same expense.

The plan above recommended is not only adapted to drain the low lands in question, but the same principle will serve to drain most, if not all, the Fens and lowlands in England, for there are but few, if any, in this kingdom, but what have a fall to the sea, and that fall is the same in winter as in summer; the reason of all such lands being drowned is, because the waters, coming from an extensive high country, either immediately break out of their channels, or that they rise too high and override the sockage and downfall waters at the places where such waters are intended to drain into rivers, which bring down such highland waters.

That the plan here recommended is practicable, and will be attended with the salutary effects before mentioned, can be proved by experience, which far exceeds the opinions of the ablest engineers; for of all the demonstrations and arguments that can be made use of, none are so satisfactory or explanatory as experience; and for this I shall refer any gentleman interested to view Holland Low Fen, and the low lands adjoining, which are drained upon the principles above mentioned, viz., separating the high land waters brought down Kyme Eau and the river Witham from the sockage and downfall waters of the Fens and low grounds, and carrying these waters to a lower part of the outfall, and discharging them into the said river of Witham below Boston. Every winter furnishes us with the unspeakable utility of this plan; for the water in the river Witham and Kyme Eau, near Chapel Hill, during the winter season is higher by several feet than the surface of the lowlands adjoining thereto, and at the same time those lands are dry and well cultivated below, and solely owing to the method of running the waters into independent channels eleven miles, and all those waters of the Kyme Eau, the river Witham, and the said low lands, unite and run together when they get below Boston, though it would be impossible to run the waters of the low lands into the river Witham near Chapel Hill in the winter season, because the flood waters run several feet higher there than the surface of the lands to be drained. Any gentleman that has seen Holland Fen and the low lands adjoining the same (which used to be the sink hole of all the country), can testify that those lands are now become well drained and cultivated, abounding with corn, cattle, and inhabitants, while many thousand acres of other lands that might be equally as well drained by adopting the same principles, are almost perpetually drowned; and by collecting and embanking the flood waters of the high country, the haven of Boston is every winter scoured out to its ancient hard clay bottom, and ships of considerable burden lie afloat where the people have walked across in their shoes at low water, and not get wet-shod; and large ships can now sail where it was before difficult for lighters to pass, and all this alteration is caused by the current is a short space of time, though the works that are proposed to be done are yet far from being finished. I therefore would humbly advise the noblemen and gentlemen interested in draining the Middle and South Levels of the Fens to take experience as their future guide, and no longer depend upon the fallacious and ill-grounded reports of self-interested and designing men, whose business has ever been to multiply the difficulties of a general drainage, that they might the more readily fatten upon the spoils of the country, by multiplying jobs for themselves and friends. Among those vultures of society that have infested this part of the country are the engine builders and jobbing engineers, who have combined together to the almost total ruin of the landed interest in those Fens. I had an opportunity of showing Lord Townshend, on the spot, the utility of the principles here laid down, by a small experiment. The waters of the river Ouse and Mildenhall river were separated from those of the Fens on the east side by a bank, and had no communication with the river waters till they emptied themselves into the Ouse near the mouth of the Brandon river; we took the levels from the surface of the water in the Ouse at the junction of the Mildenhall river to the surface of the waters in the Fens adjoining, and found the latter two feet nine inches and a half lower than the other, though they were only separated for about four miles, and at a time of the year when no floods were out, the lands on one side the Mildenhall were dry and those on the other drowned. I should think this experiment, though in miniature, might sufficiently show every person what great advantages might accrue by adopting the same principles, only a larger scale, for draining the whole Levels.

From the little time I had to spend in those Fens, and for want of proper levels and sections of the rivers, I could not be so particular in my observations as I could wish, nor would I wish an Act of Parliament to be obtained on this Report without first taking the opinion of Mr. Jessop, Mr. Smith, or some other skilful engineer.

I have conversed with Mr. Ellstob, the engineer employed by the Corporation of the Bedford Level, on the above plan, and he by no means seems to approve of it. His first objection was, the water in Lynn river would revert up the side drains, if there were not pointing doors. In answer to this objection, I told him there must be a sluice with pointing doors to stop the tides from flowing up these drains. But then, says he, there will be such a quantity of high land water come down the river as will keep the pointing doors shut, and by that means prevent the side drains from running. In answer to this, I say, that low water mark, where the sluices are proposed to be built, is much lower than the low lands to be drained, and therefore that objection will not hold, which experiment has sufficiently shown at Boston. But then, says Mr. Ellstob, we have a precedent in the HundredFoot river, for the waters come down in such quantities, that they reverted up the Ouse and obliged the Corporation to build Denver sluice, and since Denver sluice was built, those waters kept the doors shut for several days together, and prevented all the lands above it draining into the Ouse. This I admit to be true, but what is this owing to? To three causes: the first is, that the surface of the waters so high up the river as Denver sluice is seldom so low as the low lands to be drained, which, I think, I may venture to say, will never be the case so low as Lynn. The next thing is, the Hundred Foot waters come down from Erith in a straight line, and the Ouse waters come many miles round, and consequently the others getting down first, rise above the waters of the Ouse and keep the doors shut. Another thing is, that the river below the Hundred Foot river, particularly above German's Bridge, is not of capacity sufficient to receive all the waters that empty themselves out of the several spacious rivers, viz., the Hundred Foot, Old Bedford, Nene, and Ouse, which all come in or near the same place, and, therefore, as these waters cannot find a passage downwards, those that come down the nearest way and get down first will in time of floods revert up the others, or keep the pointing doors shut till the other waters come down, and rise a sufficient height to force their way to sea through the passage that is sufficient to receive them as they come down. But this can never be the case if the waters are carried down to Lynn in the manner proposed; they will there discharge themselves into a spacious outfall that opens in the sea a little below.

But then, says Mr. Ellstob, by dividing your waters you ruin your outfall.

In answer to this objection I say, the outfall will then be at Lynn for all the lands to be drained, and will then be united with all the other waters, and consequently will act with their united force to keep their outfall clean of the sand, &c., brought in by the tides; besides, the living waters being strongly embanked, will come down with greater velocity than they do at present; this, added to the influx and reflux of the tides, must drive out the matter, and keep Lynn harbour much cleaner than it is now.

JAMES CREASY.

October, 1777.

In 1791, Mr. Watté was applied to for his opinion by some gentlemen, proprietors of lands in the South and Middle Level, who, having sustained great loss in the destruction of their crops, anxiously turned their attention to the inquiry whether the evils under which they suffered could be cured by a judicious system of drainage, and especially whether that result would be obtained by a new cut, proposed by Mr. Kinderley, from Eau Brink to a spot about a quarter of a mile above Lynn harbour. The following is the Report he delivered:—

In pursuance of an order to me directed from several gentlemen, proprietors of lands in the South and Middle Levels of the Fens, called Bedford Level; and of those lands in the county of Norfolk, bordering upon each side of the river Ouse:

By which I was desired to take the fall, levels, soundings, &c., of the said river and channel, from above St. German's bridge, to a certain place in the haven, or bay, called the Crutch, about two miles below the port of Lynn; and to give my opinion in respect to a new cut or channel (formerly proposed by Mr. Kinderley) to be made from a place called Eau Brink, about three quarters of a mile below St. German's bridge, across the lands, to about a quarter of a mile above Lynn harbour; and what effect such cut or channel might have upon the drainage of the said Levels, marshland, and other lands, bordering upon (and draining into) the river Ouse; and how far it might prove salutary or detrimental to navigation up and down the said river, and to the harbour of Lynn.

In consequence of such instructions, I proceeded upon the business in the latter end of March, 1791, beginning at St. German's bridge, and took the soundings or depths of water in the said river at low water, upwards to Polver's Goole, above St. Peter's church, and found it to be from six to eleven feet and a half deep, except where the current sets across the channel, and casts up sand banks and shoals, at which place it was from four to four feet and a half deep. From St. German's bridge I took the soundings downwards to the Crutch, and found the water was of various depths, from sixteen inches to fifteen feet, as appears by the line and scale of levels with the soundings herewith delivered.

The river above St. German's bridge, and to about four furlongs below the same, is confined by jetties; and is in width about two hundred and seventy-five feet. The bridge has a water-way of one hundred and sixty-six feet. From Eau Brink to a little above the port of Lynn, the channel was from sixteen inches to fifteen feet deep, unconfined, and running in a serpentine course, between banks placed from one to six furlongs asunder, through high shifting sands and shoals, so that it is continually changing from one side to the other, as the flow and ebb of the tide, or a rough sea, operates; the current cheques in from one shore to the other; and, setting hard against the banks, forms eddies and pools under the same, fifteen, and sometimes twenty, feet deep at low water. In stormy weather and spring tides, the water from so expanded a surface being agitated, dashes violently against the banks, so lacerates and tears them that they are in eminent danger of breaches, and rendered so very expensive to maintain, that some parts thereof can scarcely be supported by the income of the lands they are made to defend.

From a little above the port of Lynn, and through the harbour, the channel was wide, and in some places very shallow, and is frequently changing by the setting of the current, and, I understand, was often nearly choaked by the sand banks and shoals thrown up or brought there by the tide, on its influx and reflux, particularly where it sets over or crosses the harbour from the place where the ships usually lie, to West or Old Lynn; from thence it continued under the western shore past the Ferry Staith, down to where the bank turns off for Terrington marshes, and then it ran by the Green marshes and through the sands in a curved direction, and very shallow, to the Crutch, at which place it was of a more equal depth and deeper water, though still running between sand banks quite down to the Bar Beacon, and so to sea. In passing through Lynn harbour, I found the same to be very wide, and much incommoded with high shifting sands, extending quite into the middle thereof, which render the navigation extremely hazardous, particularly about the place where the channel crosses; and on such moveable sand-banks, vessels, whose pilots are not perfectly acquainted with the navigation, or in stormy weather and a rough sea, are sometimes over set, of which there have been recent instances.

On my proceeding down the river, I made the following observations; at the Gooles, or outfall sluices, as I passed by, viz., at the Goole called Polver's Goole, there was but little run of water into the river, and the border-lands, which drain thereby, were much overflowed, nearly up to the hard lands. At the Goole called St. Mary's Goole, below St. German's Bridge (lately erected), the water ran through the same, for a few hours before low water, in a languid manner, and near Saddle Bow some of the lands which drain through it were wet and soaky, the water in the ditches being equal with the surface thereof. At the Gooles called Knight's Gooles, erected for the drainage of the greater part of Marshland, I found the water to run, a few hours before low water, with but a slow current, across the shifting sands of the channel. I understood, that after high tides with stormy winds, they are frequently choaked up; and run but little for days together, even at the lowest water; but when the land floods, or freshes, come down, the water for weeks together is known to run from two to two feet nine inches higher at low water than when I took the soundings. During that period, there is not the least water passes to sea, but lies upon the surface of some thousand acres of as prime land as any in the kingdom which drain this way, to the great damage of the same, and injury to both the proprietors and occupiers thereof; as I understood at the time I took these minutes, the water was near a foot deep upon several acres of the high or inside lands, and from two to four feet deep upon the lands called Marshland Fen. The water was deep upon the floor, or sea apron, of the Lower Goole five feet ten inches, and had fallen during the course of the spring only about nine inches at the tail or land side thereof; a pitiful outfall indeed for the drainage of five-and-thirty thousand acres of land!

Tilney and Clenchwarton Gooles, which open into the channel lower down, I found much incommoded with sands, and nearly choaked up; but as the lands draining through them (about four thousand acres) lie very high, they may, with industry and great expence in cleaning the strings or outlets, by hand, at certain times of the year, make shift to get rid of their waters this way; but I am certain they would have a much better outfall, were the drains carried within side the bank, down to Old Lynn.

From the above observations it appears, that both drainage and navigation by this river are reduced to a deplorable state, and I fear are getting worse, by the sand-banks and shoals continually rising, which manifestly appear by the outfall of Marshland and other drainages, as ten or fifteen years ago they were in a much better state; and if we may argue from analogy, and infer from consequences, what has been gradually growing for that number of years past, what state of drainage may we expect the country to be in ten or fifteen years hence; and what in a longer period, if nothing effectually be done to improve and secure the outfall to sea; as wind-mills, the last effort, and the only expedient at this time that can give relief to the low lands, I fear also must be deserted ere long, as they are now got to the last degree in size, if not improvement. But provided that such an artificial (at the best uncertain) drainage could be carried on for a series of years at a tolerable expense, I beg leave to ask in what competition does it stand to a natural one by a certain and good outfall? The censure of the one or an eulogium on the other, it will be needless for me here to insist upon as absurd, and would be considered as an attack upon the good sense of mankind. Low-water mark in this river is gradually getting higher: and in time, it is my opinion, that the waters, without frequent land-floods happening, will not be able to force their way to sea through the sands and shoals, they being often divided, and in the last quarter's ebb run so languidly and shallow, as to lose all power of grinding. Such low-water mark I understand, from good authority, is now three feet higher at Denver sluice than it was in the year 1777, when Mr. Golborne made his observations and report.

The above being mostly from observations made on the water, I now proceed to those made upon the land; that is to say, the line of levels, or falls, taken from St. German's Bridge to Eau Brink, from thence across the lands in a straight direction to Lynn channel, or harbour, about two furlongs above the town, or to a place where the proposed new cut or channel would fall into the present one, and from thence down to the Crutch; but the latter part was not taken in quite so regular a manner as the former, owing to the quicksands and other impediments.

The said levels were taken from low-water-marks, made at the water's surface in small spring tides, when there was not the least land flood, or fresh, in the river, which I found to vary but little from those taken in

the neaps, so that it was not the most favourable opportunity to gain the greatest fall: such water-marks were taken at the same instant by persons appointed at the several places: and that part of the line of levels from German's Bridge to above Lynn, was taken forward and backward by a very accurate instrument; and, to shew the accuracy of the same, there was only one inch and seven-tenths difference in the operations of fifty-eight stations (or in placing the instruments so many times); so that any calculations, report, or opinion, may safely be grounded upon the FALL as given by those levels, without the least doubt or suspicion of being betrayed into error thereby. Thus much I thought well to premise, it being the foundation, or basis, on which that most important superstructure is to be erected, viz. the salvation of a long-neglected country by the drainage of three hundred thousand acres of inundated lands!

It appears from the said levels, that there is a fall from German's Bridge to Eau Brink of six inches, being six furlongs, or three-quarters of a mile; from whence across the land in a straight direction to a little above Lynn Harbour, I find the fall to be four feet ten inches and four-tenths, the distance being two miles and three quarters; and from thence to the Crutch, the fall is two feet and six tenths of an inch, the distance being three miles; so that there is a fall of water, in the distance of six miles and a half, of seven feet five inches, a fall more than sufficient (if acting in a confined channel), to lower the surface of low-water at German's Bridge four feet and a half, as will appear by the following illustration. It is universally allowed, by those who have made the doctrine of fluids their study, that three inches fall in a mile will produce a brisk current in a stream or river, but doubtless, a fall of four inches in a mile will produce one much more so; so that, allowing four inches in a mile for the current from German's Bridge to Lynn, where the channel is intended to be confined, viz. three miles and a half, will make fourteen inches; and allowing in the other three miles, six inches per mile, will be eighteen inches, (together two feet eight inches); which taken from seven feet five inches, the whole fall, leaves four feet nine inches, and so much would low-water-mark be lowered at German's Bridge, by turning the river down a straight cut or channel.

Nearly the same would take place at Denver and Salter's Load sluices, as well as the rivers freely communicating with this, and would be proportionably felt at the outfall of every drain throughout the said South and Middle Levels. It would be a certain drainage to all those borderlands which have their outfalls into the river Ouse below Denver sluice, and would prove effectually so to that valuable tract of land called Marshland, except the low parts of the Fen, the drainage of which could easily then be completed by the assistance of an engine-mill.

I would therefore recommend the deserting of the present channel (making a dam across the same), and the opening of a new cut or channel from Eau Brink, across the old lands and marshes, to about two furlongs above Lynn; the said cut to be made at the upper end of the width of the present river, a little below German's bridge, and the lower end to be wider (to give an adequate indraught to the tides), to have banks formed at a proper distance on each side thereof, with the earth coming out of the same, and to have two piers at the mouth or entrance thereof from the sea, made with rag or other common stones. But in the execution of it, attention should be had to the soil or materials it would be carried through, as, if it be composed of strong clay, it should be made in the first instance to the width and depth intended; the bottom should be formed with a declivity, and at least six feet lower than the low-water line. But if it should be found a silt or sandy soil, it would not be necessary to take those precautions, as with proper care, and the use of the spade machine, it might be ground down to any depth required.

By the making of such new cut, and turning the channel, it would prove of very great advantage to those who have banks to support against the present channel below Eau Brink, which heavy expenses, in a little time, they would be released from. The said channel in a few years would be quite silted up, and become good and firm land, the sale of which would in great measure pay the purchase for lands used in the new cut, its banks and forelands, or the money arising by such sale might be applied generally to the payment of any other debts that were contracted in carrying the said proposed works into execution.

The use of the spade machine I would also recommend in the rivers above, to take down the sand banks or shoals; and have but little doubt by such management, after the cut were made, of grinding down the bottom of the river Ouse, to lower or reduce the water's surface equal to that at Lynn at this time, or five feet and a half lower at German's bridge than it now runs. This is from opinion; but the above reduction of four feet nine inches is deducible from mathematical observations, physical truths, and stated facts.

What makes me more fixed in my opinion, is by a recent and similar instance, by a like cut made at the outfall of Wisbech river, which has had all the desired effects, though the undertaking had not that apparent certainty, nor was it of equal magnitude with this; and, from certain and known facts, I can speak to the same, as, before it was executed, I was called upon by the Commissioners of Tid and Newton drainage to take the levels from their outfall sluice to Gunthorpe sluice, when the water was deep upon the floor, or sea apron, of Gunthorpe sluice, seven feet, during the winter season, at low water, and in the year 1782, I was called upon by the Commissioners of the Bedford North Level to take the levels and soundings of Wisbech river, from Peterborough bridge down to Gunthorpe sluice, at which time the water ran six inches deep upon the said floor, viz., six feet and a half lower than it had done for several years preceding the making of the said cut.

This cut was also proposed by the same Mr. Kinderley some years ago, and was made from a place called the River's End, to carry the channel through the green marshes, about a mile and a half in length, to avoid the moveable sand-banks and shoals in the bay it passed through on the Norfolk side thereof; and which had the proposed effect of lowering the waters at Gunthorpe sluice (the outfall for the North Level, Portsand, part of Sutton Holland, and other waters), six feet on the first opening of the works; which prodigious fall gave immediate relief, and secured the drainage of the above and other valuable tracts of land, draining by the said river, and rendered a distressed and almost desolate country once again flourishing, to the then great comfort, and the present enriching, of numerous families, as well as an acquisition of some thousand pounds per annum to the community at large. It had also the most salutary effect on the navigation to the port of Wisbech, which town it relieved from its depressed state, and rendered it again respectable, and it is now, for its magnitude, as flourishing a place in trade and commerce as most in the kingdom.

The effect which the proposed cut would have upon the navigation in the river Ouse, would be of great importance to trade, as shortening the distance would accelerate the passage of the craft going thereby to and from Lynn, and render the same safe at all times. They would then be conducted by a channel sheltered between banks, and not liable to be exposed to the violence of the winds and tides, and danger of the sand-banks, which now attend the navigation through that dangerous river (or rather bay) from Lynn to St. German's, where merchants and traders meet with so many disasters, losses, and frequent delays, that trade is now carried on thereby with great hazard, much difficulty, and considerable expence. As to any idea or fear the traders may have of the craft being rendered unmanageable by the rapidity of the current, would be extinguished a little time after the intended cut or river were opened, particularly if a land flood should quickly follow, as the current shortly after that would run smoothly, or in the same manner the upper part of the river about German's bridge now does. The effect it might have on the harbour of Lynn, I cannot conceive would be attended with any of the dangerous consequences as some are so much alarmed at; but, on the contrary, would be of great use thereto, if the waters coming through the cut were properly pointed down the channel through the harbour, and exertions used to assist it by throwing out jetties, &c., at proper places; by such means there would be a great probability of bringing the channel along by the town at such distance as desired, and to fall down to the Crutch in nearly a straight direction. As to the danger of the current raising sand-banks or bars across the channel, as seems to have been suggested by some, I cannot by any means agree to, it not being like a head of water held up by a sluice, or reservoir, for a scour only, which, when let off for want of a continued back-water, goes off with a flash only, and often produces the effects alluded to, of blowing deep holes or pools just below the outlet, and, by its expanding and growing weaker as the distance increases, lets fall again those particles of sand and soil it is surcharged with, and there forms bars or banks; but in this case the waters passing through the cut or new channel would have a different effect, as the shortening of the indraught of the tides, and reducing the low-water mark; the tides therefore would flow much quicker, consequently higher up the rivers than they now do by several miles, and would form a deep and large column or body of water that would descend upon every ebb with a great force or momentum (by then it got into this harbour,) that would continually grind and scour the bottom of the channel, and take away with it all those particles of sand or sediment that might be brought in with or deposited by the tide during its flow. It may be asked, if the tides were to flow higher up the rivers, would not the banks above the cut be in danger of being overflowed? In answer thereto, I do not mean by the tides flowing higher up the rivers, that they would flow higher against their banks in that degree, as may have been supposed by some, but that they would certainly flow something higher in still tides against the banks above than they do now, by reason that the distance from the bay would be shortened, consequently they would require less time (with the same velocity they run with now) to come to or reach any assigned point in the river above; therefore, the impulse from the sea would not be withheld whilst the tides were further advanced up the river than they now are, as the climbing over the sand banks, by the friction against the bottom of the present channel, and the distance also considered, must retard their motion at least three quarters of an hour in running up to German's bridge. But I think

high tides, accompanied with violent winds, do flow (as this river or bay is circumstanced) at that place and above it, nearly equal in height or to the same level with the sea now as they would then; in consequence thereof the banks above would be in no more danger of being overflowed after the cut was made (upon the dangerous tides) than they are at present; but this I think would admit of a demonstration, if it should hereafter be found requisite.

I submit the foregoing observations and opinions with due diffidence, hoping my employers (and all others whom it may concern) will excuse the manner in which they appear, as, from the hurry of the business, had not time methodically to arrange them, and treat of the matters herein contained in the manner I could have wished, and which the importance of the subject demands.

JOHN WATTE.

Wisbech, April 21, 1791.

REPLY TO THE REPORT OF JAMES WALKER, ESQ., C.E., ON THE BAR OF NEWHAVEN HARBOUR, SUSSEX.

SIR,

THE construction and improvement of harbours, and especially of 'bar' harbours, have been for some time, and are still, subjects of great interest to the scientific world; and I am therefore induced to request the insertion of the following remarks in the columns of your valuable Journal.

The importance of the subject to this great commercial and naval nation, should admonish us to pursue the investigation with cautious and serious consideration, but, unhappily for the cause of truth and the advance of science, a name too frequently takes the place of knowledge; and in no case has this been more fully exemplified than in Mr. Walker's Report on the Harbour of Newhaven. This production would certainly be discreditable to any young man who had been twelve months in the office of an engineer; but the name of James Walker, Esq., F.R.S., and President of the Institution of Civil Engineers, gives it authority amongst a certain class of persons as a production of high character. To confirm this statement, I need only refer you to the debate at the meeting of shareholders, on the 2nd of May, when Sir Henry Shiffner, Bart., the Chairman, is reported to have said, that "the subject of harbours of refuge had been brought under the notice of the government, and that in the House of Commons, the harbours of Rye, Ramsgate, Harwich, Shoreham, &c., had each its champion, but poor Newhaven Harbour was not represented. It was for that reason he suggested, about twelve months ago, that the trustees should select a person connected with government, so as to make a link between Newhaven Harbour and the government, and thereby have its claims brought fairly forward. He could state, that since the last Meeting, through Mr. Walker's Report, the state of Newhaven Harbour had been fairly placed before government. It has been brought forward just at the time when they talked of selecting a harbour of refuge. I should like to see Mr. Walker's more expensive plan, that of extending the piers, carried into effect: *Every man of celebrity* says, 'extend your piers, extend your piers;' I do feel disposed to look upon this recommendation as worthy of the consideration of the trustees."

You will, Sir, perceive from the above, that the trustees of this harbour have been more anxious for connection and a *name* in their selection of an engineer, than for a sound scientific opinion to guide them in improving their harbour.

But I owe it to the profession of Civil Engineers, and, indeed, to the nation at large, to prevent, as far as is in my power, even the President of the Institution of Civil Engineers, with his high titles, from trifling with a subject of so much importance as "bar harbours." I will, therefore, follow Mr. Walker in his irregular steps from the beginning to the end of his Report:—

"The object of the application to me," says Mr. Walker, (although from Sir Henry Shiffner's speech he seems to have been in this much mistaken,) "is given generally in the notes I had the honour to receive from the Earl of Chichester, but more particularly in a letter received from the clerk of the Commissioners, bearing date the 18th of May, 1842. This letter states, that the mouth of the harbour is occasionally, during strong westerly winds, partially blocked up by the shingle or beach drifting from the westward, which, it has been suggested, might be prevented by erecting a groyne to the westward of the west pier. The Commissioners are, however (you inform me), anxious to obtain my opinion and advice previously, as to the propriety of it." This is the subject upon which Mr. Walker is desired to report, or, as stated in the last Number of your Journal, as a heading to his Report, *the Bar* of Newhaven Harbour; but how does he comply with these instructions? how does he report on the drift of shingle, or the bar? He views the bar exactly as a judicious pilot would in a gale from the south-west, or in a great storm, for the sake of his own life and the security of the ship and cargo with which he is charged—that is to say, he runs away from it with as full a sail as he can carry. Mr. Walker answers the questions of the Commissioners respecting the drift of shingle and the removal of the bar, by proposing another, which, he states, is a more troublesome one than the question of shingle; viz. the origin of the heavy sea in a south-westerly wind, and having set sail with this wind, he never returns to examine the cause of the drift of shingle and formation of the bar, upon which he was especially called to report.

By his own account, he had all the data, documents, evidence, and information requisite for any engineer to form a sound and practical scientific opinion. Indeed he had the evidence, &c., of pilots, harbour-master, officers, and interested individuals, with Captain Bullock's surveys, which very few persons could have had, and the want of which is so often felt by engineers when they are engaged to report on our harbours. The value of Mr. Walker's opinion, with all these advantages, I shall presently show.

Before he gives any opinion of his own, he explains, as all engineers ought to do, what has been previously done, and states that the harbour has been much improved of late years; and in this conclusion I perfectly agree. This has been chiefly effected, he informs us, by clearing the harbour of shoals, so that the tidal water is admitted more freely, and in greater quantity and force; with this also I perfectly agree, but he adds, "and partly by the extension of the east pier, which has confined the out-going current to act upon the bottom, *and drive the shingle into deep water.*" Driving is Mr. Walker's alpha and omega in harbour engineering; but surely it requires little foresight to see, that the shingle which the flood brings in alongside of the west pier, it drives out upon the bar across the harbour's mouth. That the system of *driving the shingle* out of the harbour will prove abortive, we have only to look at Mr. Walker's driving sluices at Dover, which throw the shingle from the end of the west pier into the air, as jugglers cast up balls, and then quietly allow the greater part to fall exactly opposite the mouth of the harbour: just in proportion as his sluices *drive* the shingle from the end of the west pier does the bar increase. Mr. Walker's name may sanction the *driving system*, but the laws that govern the motion of the drift of shingle, and the waves and seas, on the south-east coast, *will not*.

Mr. Walker states, that no harbour upon the south-east coast, as low as Portsmouth, has so good a natural backwater, or is more capable of improvement. This must be a great error, and no other

engineer would have hazarded such an opinion upon the capabilities of Newhaven Harbour; any fisherman on the coast would have told him a different tale, and I cannot make out how Mr. Walker can reconcile this statement with the one made by the Commission appointed in 1839, of which he was himself a member, and to which his name is attached. I will prove to your readers, at some future opportunity, that Shoreham and Littlehampton, on the same coast, have daily many hundreds of tons more backwater than Newhaven.

Mr. Walker further states, that Mr. Jessop, in 1819, reported "that the water which was discharged from the harbour expanded itself too soon to the eastward, and that the current was diverted before it reached the extremity of the western pier." This was only the effect of placing the western pier rectangular with the coast, and the consequence was, as stated by Mr. Jessop, "a considerable deposit of shingle within the west pier." But had the west pier been so constructed as to curve to the eastward, no deposit could have taken place: if we may be allowed to take for our guide those invariable laws which govern the motion of water, we shall always find that the out-going water will attempt to escape at a tangent to the curve. No deposit of shingle, nor of other matter, could possibly shelter on the concave shore of the west pier; and the necessity of either a dwarf or any other piling, would have been avoided, by keeping the out current from flowing eastward. Mr. Walker states, that the work executed according to the recommendation of Mr. Jessop produced only a partial good, because it allowed the expansion of the backwater at the first half ebb, which he states to be the strongest. In this Mr. Walker has committed himself, for his assertion cannot be supported by facts, not even in the harbour upon which he has reported.

I shall not now allude to the bearings and positions of the piers, but proceed with Mr. Walker to consider his main point. Something, he says, is wanted to break off the seas before they reach the entrance of the harbour, and he further informs us, that the winds which bring shingle round the end of the west pier lay it up in the entrance; the accuracy of this assertion I must be allowed to doubt. The south-western winds do not bring the beach into the harbour, but the natural effect of those winds is to carry the shingle on its track to the eastward. The piers, however, from their position, have a tendency to draw the beach from the very arms of the waves caused by those winds into the mouth of the harbour.

"I have," says Mr. Walker, "to report my opinion of the two evils, the first being, as I have already said, the greater." The latter, however, which, in fact, was the one Mr. Walker was requested to report upon, is not in any way mentioned in the remaining part of his extraordinary document—he does not venture a single opinion on the drift of shingle, and accumulation of a shingle bar at the harbour's mouth—he does, however, suggest some plans by which to break off the sea, and improve the harbour; but unfortunately Mr. Walker's system is only that of "*try, and I shall be glad if it answers.*" His first suggestion is that of extending both piers 130 feet seaward. But will this answer the purpose? We will judge Mr. Walker by his own statements. In the former part of the Report he says, that the cause of the swell in the harbour and between the entrance piers is to be attributed to the circumstance of the piers being of equal length, and since their extension the seas "rebound from the east pier into the entrance, so as to produce agitation, and to confuse and stop the way of ships entering" the harbour. Yet he proposes to carry out the two piers, in the same direction as at present, 130 feet: will any engineer, excepting Mr. Walker, pretend to say, that by carrying the piers seaward without altering their position, the swell at the entrance of the harbour would be diminished? Mr. Walker speaks of this plan as "a continuation of the system which has hitherto been pursued;" but this cannot be, for he proposes to widen or set back the piers 10 feet, and to make the harbour's mouth 20 feet wider. The consequence of this may be with certainty predicted. It will produce the same effect as at Littlehampton. On the flood tides, the tortuous south-westerly waves in entering the new piers would strike the set-off, or the angle of the old or present piers, and the volume of water entering the harbour between the new piers, being compressed 20 feet, the velocity would be increased so much as to swamp, or at any rate greatly endanger a vessel, and make her perfectly unmanageable; on the ebbing tide, the backwater, tidal and effluent, in returning through the old or present piers and entering the new, would certainly rush violently out and scour all before it, as is the case at Littlehampton; but in entering the new, the volume of water in the distance of 130 feet would be allowed to expand 20 feet, and the piers being rectangular with the coast, the angle of the west pier would in one winter be filled up, and the bar be increased to a fearful extent; or, in Mr. Walker's words, "would, without a doubt, become *troublesome.*" How he finds out that the shingle is *likely* to pass the east pier, I am at a loss to discover, as he makes no allusion to any law by which he obtains those *likely* results. The assertion is ridiculous, for the piers would, without doubt, draw the shingle into the harbour's mouth so long as their position remains the same.

Mr. Walker's next proposition is to erect a groyne, or jetty, at Fricker rocks, and a more visionary plan could not have been suggested: this groyne is proposed to be constructed 1,100 feet west of the entrance. If this celebrated engineer had only carefully watched the effects at Dover Harbour, produced by a similar groyne, called Cheesman's Head, it would not be necessary for me to have proved such a work must be abortive. Messrs. Rennie and Walker, when reporting on this subject, said: that "The beach which is brought along within the sea, is projected outwards, and carried quite past the space which lies between the said jetty and the western pier of the harbour, which space is above 500 feet; but by the time it has got opposite to the present west pier it has lost its force, and there finds shelter; from thence a bank of nearly 300 feet in length extends, which frequently shuts up the mouth of the harbour to such a degree that vessels drawing 3 feet water can scarcely enter." You will perceive that this groyne, although only 500 feet to the west of the harbour, increases the beach at the harbour's mouth, owing to the force being lost. What then would be the effect of this groyne of Mr. Walker's, which is twice the distance; it would increase the bar, without reducing the swell. But on this subject I need only refer you to the evidence given before the parliamentary committee on Dover Harbour.

Mr. Walker's third proposal is, as he states, that of Mr. Stevens, the harbour-master, and this is the one he not only recommends the Commissioners to adopt, but places great confidence in it, because it is the suggestion of Mr. Stevens, whose experience and long acquaintance with the harbour, give, in his estimation, an authority to the plan. This is either very modest, or very imbecile. Contrast it with the answer of Mr. Walker to the Parliamentary Committee in 1836:—"I have found that sailors, who have a complete command on board of their own ship, as they have been used to manage everything on board, are apt, when they get on shore, *to think that they know everything;* and they are very apt to have plans and schemes of their own, in which they are very positive." There may be, and there are, exceptions to this rule, but giving every allowance that can be claimed by the President of the Institution of Civil Engi-

neers, I am certainly surprised to find him condescending to gather an argument for the adoption of a plan he recommends from the authority of a common sailor.

But the truth is, that Mr. Walker finds the task of preventing the drift of shingle and the formation of a bar too difficult a subject for him to investigate, and having no opinion of his own, he begs his employers to *try Mr. Stevens's plan*. "I consider it the best;" and, "*Should the shingle between the piers continue to be troublesome*, I think it may be removed without much expense; and I shall be glad in this to find *Mr. Stevens's opinion*, that the groyne will pass the shingle clear of the harbour's mouth, *to be correct*."

Having delivered this notable opinion, the great engineer concludes with a promise, which ought to be very consolatory to the Commissioners, that at a future time, if they should obtain sufficient funds, he will give *his own opinion*.

In conclusion, I beg to disclaim any personal or ill feeling towards Mr. Walker; but, in the investigation after truth, I have felt myself bound to speak in terms of severity of the manner in which he has reported on this harbour.

The subject of Bar Harbours, especially on the south-east coast, has been much neglected by engineers; but it is one of such vast importance to the British Empire, that I trust some of your correspondents, more able than myself, will be induced to communicate their observations and opinions.

I am, Sir, your obedient servant,
AB. GWILIM.

NEWHAVEN HARBOUR.

Sir,

Having read Mr. James Walker's Report on Newhaven Harbour, I beg the favour of your indulging me with the insertion of the following letter.

It is not my intention to wade through the whole of this Report, as it would occupy more space in your valuable Journal than you could conveniently spare, or than I could have the conscience to ask.

There appears to me to be a want of candour on the part of those who are immediately connected with this harbour, in not stating to those gentlemen who have been called on for their opinions, the effects that have been produced by the different alterations which have been hitherto made; but Mr. Stevens's appointment of not more than twelve years must exonerate him from any charge of concealing from Mr. Jessop, in 1819, and as I was witness to the building of the piers, I must claim a decided advantage over Mr. Stevens.

In the progress of this work Mr. Louch, of Uckfield, had the management, and he deemed it necessary to build a groyne to shelter the west pier, which, from its exposed position to the sea, must have required protection: it was merely a temporary erection, being built for no other purpose than that I have stated. When the piers were complete, it was not considered to be worth the labour of removing. Now, Sir, I state as a positive fact, that as long as this groyne stood, the harbour ran straight to sea in a SSW. direction; there was neither pole nor shoal that offered any obstruction to the entry of ships into the harbour, and it never shifted, the channel uniformly continuing in a SSW. direction. In the course of time this groyne fell a victim to the sea, and was completely washed down, and from its destruction changed Newhaven from a good to a bad harbour; every westerly gale threw a large quantity of beach before the entrance, and the channel shifted to the eastward, until it ran close to the east main; the ebb tide at last would no longer be constrained to follow in that course, and broke through the beach at the entrance, and for a short time the channel ran straight to sea. This circumstance occurred several times in a winter, or on a long continuance of strong westerly winds.

This fact, I presume, cannot have been communicated to any of the gentlemen, who, through the Commisssoners, have been solicited to prescribe for the harbour improvement.

In this situation of the harbour, Mr. Jessop, it appears from Mr. Walker's Report, was consulted, and, as stated by that gentleman, a dwarf piling was recommended, extending as he describes, and it produced a partial good. I beg leave to state the effect this dwarf piling produced; it conducted so large a quantity of beach into the harbour, that it soon became a matter of necessity to invent some other machine to drive the accumulation of beach from the west pier, where it had obtained a lodgment. Now, if Mr. Jessop had been informed of the great service rendered by this temporary groyne while it stood, would he not have resorted to its rebuilding, and further extension if necessary, in preference to this dwarf piling?

As all this occurred before Mr. Stevens's appointment to the office of harbour-master, he cannot be accused of concealing his knowledge from Mr. Jessop, and I must confess that I am at a loss to conceive how this dwarf piling, as stated by Mr. Walker, could produce a partial good. It had, in fact, a mischievous effect; the beach that it conducted in, it conducted out, and so far out that it could not find a lodgment on the east main, and produced the necessity of building groynes for the preservation of Bishopstone mill. This cannot with propriety be called a partial good; it might assist the scour, *but I am quite satisfied the scientific gentlemen are too partial to the scouring system. Their efforts would be attended with much greater success, if their study was more directed to preventive measures.*

I presume Mr. Walker could not have been informed of the effect produced by the extension of the east pier, or he would not have animadverted on its production; is he aware, or has he been informed, of the consternation of Mr. Stevens and others on the first gale of wind after this extension was complete?—did Mr. Stevens inform him of his fearful apprehension for the safety of the west pier, the upsetting of his excellent work, a sort of paving along the wall at Sleeper's Hole?—was he not compelled, for the preservation of the west pier, to groyne it to support it against farther ravages of the sea? Surely, if Mr. Walker had been informed of all these incidents, he would not have risked his reputation by passing a panegyric on the merits of this extension.

It is much to be regretted that Mr. Walker, and the other gentlemen whom the Commissioners have called on for assistance, have not been informed of all the occurrences as they have taken place, that they might have had better data to work on than theory. I do think Mr. Stevens was acquainted with all the proceedings, from the building of the piers to the extension of the east pier, from information I have actually given him. He is no stranger to my ideas on this important subject, being well acquainted with them for eight or ten years past. The groyne that was erected for the protection of the pier was never considered, when building, of any importance except for what it was built; its value in keeping the harbour in a good state was never known until it was washed down; and had it been replaced as I have frequently urged, it would have superseded the necessity of extending the east pier, or of applying to engineers for advice. Mr. Stevens is entitled to great credit for the many improvements he has made,—I believe a more zealous person could not be employed; but

if the groyne were rebuilt on the spot where it formerly stood, and the east pier reduced to its former state, the harbour would run as straight as it was while the groyne stood.

I remain, Sir, your most obedient servant,
HENRY MASSY.

Portsea, May 16, 1843.

REPORT OF J. WALKER, ESQ., P.C.E. ON THE SUNDERLAND FLOATING DOCK.

Sir,

I had the honour to receive your letter of the 29th March last, in which you inform me, that application had been made to the Lords Commissioners of the Admiralty for their consent to the Bill now in the House of Commons, for enabling the Commissioners of the river Wear to effect certain improvements in the harbour of Sunderland,—that a large body of ship-owners and other inhabitants of both sides of the harbour had petitioned their lordships to withhold their consent on certain grounds connected with the well-being of the port, and that their lordships, having reason to doubt the efficacy of the proposed plan, were desirous that I should proceed to the river Wear at my earliest convenience, to carefully examine into the merits of the proposed plan, and, after satisfying myself of every important particular, and hearing all that should be adduced on either side, that I should report my matured opinion for the information of their lordships, bearing in mind that it is not more their lordships' duty to protect the water and harbours of the realm, than to offer no discouragement to substantial improvements and judicious enterprise.

So soon after receiving the above instructions as I could fix to proceed in the business, I informed Mr. Robinson, the clerk to the Commissioners, of my intended visit, so that on my arrival at Sunderland, on the 10th inst., I found the Commissioners and the opposing parties prepared to meet me, and I proceeded at once in the necessary surveys, and in hearing the statements and witnesses of the promoters and opponents of the projected measure: each party produced engineers, ship-owners, captains of vessels, pilots, and owners of property, within the limits of the proposed improvements, whose evidence during five days I was engaged in taking at considerable length, until the agents informed me they had exhausted all they could produce at the place.

I have since my return given my best consideration to the subject and to the evidence, a copy of my notes of which is delivered with this Report.

With the exception of the Monkwearmouth Dock, which is on the north side of the river, and opposite to Sunderland, having an area of about eight acres, the only accommodation for shipping in the port of Sunderland, is the river Wear itself.

The business part of the port commences about half a mile from the outer end of the piers, and extends for a distance of about a mile up the river, the general width from shore to shore being about one hundred yards. Into this space several hundreds of vessels, principally colliers, are crowded. The depth in the middle of the river varies from 4 to 10 feet at low water of average spring tides; the "lift" of which is 14 ft. 6 in. at the sides or shipping berths; the depth with few exceptions is less. The inconvenience attending the want of greater depth at the sides arises from the modern method of shipping coal. In former years the coal was brought down from the pits to the wharfs, several miles up the river: a punt or barge, called a "keel," carried the coal in "bulk," from the wharfs to the ships, which then lay in the middle of the stream opposite Sunderland, and the coal was then shovelled from the "keels" on board the ships. The time occupied in the passage down the river, and unloading the cargoes by hand, was found inconsistent with the dispatch which the increase of the trade required. The first improvement was to place the coals in boxes, each holding 53 cwt., "a Newcastle chaldron," and to load the keels with eight of these at the wharfs, whence they were floated down the river as before, and hoisted by machinery from the keels into the vessels, which lay outside the keels, but near the shore. This is still continued to a small extent, but the delay attending the passage of the punts upon the river is in by far the greater proportion avoided by the formation of railways from the pits to the stages, or "staithes," upon the sides of the river, to which the waggons are brought and emptied by "spouts," or lowered by ingenious machinery called "drops," directly into the ships. This plan, of course, requires the ships to be brought close to the shore, where there is now at low water a want of sufficient depth. The inconvenience of this is two-fold: the owners of ships trading to foreign ports, particularly of heavier burden and sharp build, complain of their vessels being strained, and avoid this port, preferring the Tyne. Injurious delay also arises from a difficulty of getting loaded vessels which have grounded at low water away from their berths, to allow of light vessels taking their places. The consequent delay is felt, not only in the harbour, but the traffic along the railway, and even the work at the pit's mouth and the local workings sympathise with it; the last link in the chain ceasing to move, every dependent link does so. It must be evident, even were this not proved by abundance of evidence, that loss is the effect of such irregularity, which is the great complaint of the port.

The next evil in point of magnitude arises from the land floods, which come down with great force from the hilly country of which the Wear is the drain.

In the harbour, which is near the sea, and of which the width and depth are greater than in the parts above, the velocity is less, unless the ships in the port be numerous; but when this is the case, particularly in the breaking up of a frost, when much ice comes down, the damage and loss are very great. A memorable instance of this occurred in January, 1841, in which the damage done to the shipping by the ice amounted to upwards £15,000.

A third inconvenience is want of room, and a fourth, the damage done to ships lying at the lower part of the harbour, by the swell that rolls in during easterly gales, which damage is increased materially if, on such occasions, a large fleet of light vessels enter, following each other, and injuring those they come in contact with.

In his Report Mr. Murray states at considerable length the various projects of docks that have at different times been proposed to remedy the evils I have described: through want of capital, and still more, I believe, through want of unanimity among the local interests, combined, it was stated, with political feelings, none, with the exception of the Monkwearmouth dock, have been executed. Lord Durham, and the Hetton Company, have improved their shipping places above the bridge at considerable cost, and at those there is sufficient depth at low water close to the wharfs, so that the evil I have described as greatest is got rid of. The principal improvements made by the Commissioners are the gradual deepening of the harbour and its entrance, to the extent of several feet, by dredging. A very large sum has also been expended upon the entrance piers.

Notwithstanding the inconveniences that have been incurred, great increase has taken place in the trade and in the population of Sunderland. The following statement is abstracted from statistical informa-

tion given in evidence by Sir Cuthbert Sharp, for some years chairman to the Commissioners of the Wear, and now Collector of Customs for Sunderland.

The tonnage in	1802	. .	74,535 tons.
„ „	1840	. .	188,769
The population in	1802	. .	19,102 souls.
„ „	1841	. .	56,053
Vend of coals in	1801	. .	227,628 chaldrons.
„ „	1842	. .	509,049
The customs' receipts in	1820	.	£16,888
„ „	1842	.	£119,960

In 1787 the average tonnage of the vessels frequenting the port was 134 tons.

In 1843, 206 tons.

I will now state very shortly the nature of Mr. Murray's plan for remedying the evils described, referring to his Report and evidence for further details.

Its main feature I consider to be keeping the water at all times up to half-tide level, or 7 feet above low-water mark, thus giving an additional 7 feet of water, independently of dredging, by which means vessels of moderate draught would be always afloat.

This he proposes to effect by placing across, and nearly in the middle of the river, two pairs of skeleton gates, each pair 80 feet in width, for the general passage of vessels. The distance between these gates and the south shore to be 140 feet, in which space a waste weir, and sluices, are to be erected, for passing the tidal water and land flood. Between the gates and the north shore a tidal basin of nearly two acres, with gates at each end, is to be made a station for steam tugs, and for locking vessels in and out of the harbour.

The nature and position of these works will be clearly understood by the accompanying sketch from Mr. Murray's plan:—The sill of the gates is to be six feet under the water of average spring tides; the top of the gates, and also that of the sluices and waste weir, to be level with high water of ordinary spring tides. Mr. Murray has not yet decided on the particular kind of sluice: he proposes to adopt that which will work most easily, and pass the water most readily. I may here state that what is here meant by "skeleton gates" are gates of which the ribs or principal framing only is fixed, the *skin* or planking being in pieces removable at pleasure. These gates are also proposed to be made in at least two heights, the upper of which is to be about 7 feet 6 inches in depth, to open independently of the under ones.

It is evident that the effect of these gates and sluices when closed will be to keep the water in the harbour up to the level of high water. Their action will be best understood by explaining the process during one tide, beginning at low water. Supposing there is no fresh in the river, all the planking or moveable pieces of the gates in their places, the main gates and one pair of the gates of the tidal basin closed. The water on the upper side of the gates, or in the harbour, must be supposed at the same time to be penned up 7 feet above low water, the excess or "following water" of the river then passing out through a sluice, or over the lower division of the gates.

Now, so soon as the tide has risen to 7 feet (the supposed level of the water in the harbour) it will force open the gates, after which ships may pass in freely with the flowing tide, either through the main gates or through the tidal basin, till the time of the high water. Then the tide will begin to ebb out, the gates being kept open for vessels passing out until the water sinks to the original level of 7 feet above low water, when all the gates will be closed. The locking in or out of the tidal basin may, however, continue even until and after low water, for small craft. It is evident, that at this period, whilst the tide outside the gates is ebbing away, the water inside will be rising by the rising of the river, or the remaining portion of the tidal water coming down, which it is supposed will be sufficient again to fill the harbour to the level of high water in about an hour and a half or two hours, at which time, say about an hour and a half before low water, the sluices will be opened, and the collected 7 feet of water will be allowed to pass through them, reducing the harbour to the state we at first found it. Mr. Murray considers that this quantity of water, passing out with great velocity at near low water, "will form an immense scouring power, deepening the channel, and lowering the bar at the north of the harbour."

A considerable piece of the flat low ground (the Potatoe Garth,) between the sluices and the entrance piers, is to be excavated to 14 feet under low water, and then covered with four feet in depth of large stones, intermixed with clay and gravel, and levelled where necessary, and the space between the lateral walls is to be paved with large blocks, to protect the scour of the sluicing.

A triangular piece of ground on the south side of the river, below the entrance to the proposed sluices, is to be excavated to form a "trap" for the seas which it is supposed will extend themselves to this space, and the water will thus be stilled before approaching the gates; and for the same purpose it is intended to take down the wall in front of the Potatoe Garth on the west side of Monk Wearmouth Dock entrance, and to substitute open framing upon which seas may break and expend themselves; also to make another breakwater screen, if required, on the south side.

The works, exclusive of purchases and compensations, are estimated at £60,000.

This abridged description of the proposed plans, and the anticipated advantages, is not intended to supersede a reference to Mr. Murray's detailed and very explanatory Report, but only to bring the main points to your recollection. The Commissioners have engaged Mr. Mylne and Mr. Rendel; and it will be seen by a reference to Mr. Murray's evidence, that these gentlemen have verbally approved the principles of his plan, but have not yet reported as to the details.

Mr. Buddle and Mr. Nicholas Wood, both of the highest character and standing as mining engineers, spoke to the present inconveniences of the harbour, and the good that would accrue by keeping the ships afloat, but did not pretend to give any decided engineering opinion on the means by which this object was to be accomplished, and the same may be said of many of the ship-owners and others who are favourable to an improvement.

The argument in favour of the scheme, and replies to objections that Mr. Murray anticipates, are so fully set forth in his Report and evidence, that I think it unnecessary to trouble you by repeating them. I also beg to refer you to the ship-owners and pilots who are, for the reasons they state, opposed to the plan. I have also attached to the evidence a copy of a Report, and some memoranda, from Mr. Leather, an engineer of eminence and experience in rivers and harbours.

Having well considered the subject and the different Reports and documents I have had access to, I must say, that the balance of my opinion is decidedly against the plan. It is ingenious, and for a river harbour of less magnitude, and less exposed to land floods and to ice, might be applicable; but for the river Wear, at Sunderland, I think the difficulties and dangers have not been sufficiently estimated, and that when fairly viewed they are such as to render the experiment (for such it may be called,) unadvisable and dangerous.

Of the reasons for this opinion, none is stronger than the danger from ice, which comes down in great quantity and with great velocity.

When it reaches the harbour, and the vessels lying therein stop its progress to the sea, it collects, is then carried back by the flowing tide, when it meets the descending ice, which increases its volume and thickness, and if at this time a sudden thaw brings down a heavy land flood, the accumulated mass of ice returns down with a force that carries all before it. I have before referred to an instance of this in 1841.

The solid mass is stated to have quite filled the river for upwards of a mile in length, and then to have come down with a power that forced ships and keels from their stations, driving them against each other, and carrying some out to sea. This was an extraordinary case, but there is no security that it may not happen again, and cases of less magnitude are not unfrequent; now I cannot but agree to an extent with the witnesses, who consider that in such circumstances the gates and sluices would be a dangerous obstruction, that there might be a great difficulty in opening or shutting them at the time, and that they might not resist the impetus of such a moving mass. Could the proper workings of three pairs of large gates, and a line of sluices 120 feet long, be depended upon at such a time? I fear not. It is proper to state that Mr. Murray thinks the ice may be brought gradually down into the impounded water, the area of which will be increased by the pen, and that the ice will be spread over the salt grasses and wide places, where it may ground and melt without coming into the harbour at all; partially this may be the case, but, as a reply to the objection, I do not agree with him—I think that he quite undervalues the strength of his enemy.

A second and partly valid objection is the difficulty the works will present to the entrance and exit of large fleets of vessels, which sometimes amount to upwards of 100 sail, all pressing to get in or out during one tide. Take first, light vessels entering with an easterly (fair) wind; these come in with the tide, and sail as soon as there is water upon the bar; those that are first go as high up the harbour as they can with safety, to make way for the others, checking their way by ropes to other vessels, or by beaching on the Ham Sands; the scramble and confusion this must cause in a harbour already pretty full, and with a strong wind and tide, may be imagined; damage is occasionally done, and mostly happens between the present entrance piers and Folly Point, near which the works are proposed. When a vessel, from missing her steerage or otherwise, is obliged to drop her anchor—she swings round—stops those following immediately astern, others follow, and a crowd of vessels are huddled together; cases of damage in this way are frequent and sometimes heavy, though not generally so, the upper works chiefly suffering. After the gates are erected, dropping anchor opposite the Potatoe Garth, which is now rather the exception, will in all cases of strong wind be the rule, as it would, I conceive, be dangerous to sail up to and through the gates with a strong tide, increased as it would be by passing between the lateral walls, so that the helm would be of little service, and there would be a danger of getting athwart the piers or gates, and damaging the vessels or works. This mode of dropping, by dropping anchor, was agreed to by witnesses on both sides, but then there was great difference of opinion as to the number of vessels that might pass in one tide, each going through the operation of dropping anchor, sweeping round, getting the anchor, and warping through the gates. Small vessels in moderate weather might, early in the tide, be locked through the tidal basin, but larger vessels would have to pass through the great gates in the way described; and I think that anything like the number, or even half the number (100 to 150 I have named), could not get through in one tide. There is also the liability, in a fleet of vessels entering in a strong tide and easterly gale, that some accident may occur, by which they may come against the works before their way is checked, or even before the gates are opened (there being 13 feet at the entrance at the time), and consequent damage to the works and vessels ensuing. Nor do I think this liability lessened by the stones with which Mr. Murray proposes to cover the ground, which may be suited for resisting the scour of the sluices, but are not favourable to the anchors holding, and which the anchors would be very apt to disturb, or they might make the anchor difficult to get.

Then, as to laden ships going out, these must get over the bar before high water, and the scramble is described as being equally great as in entering—all, so soon as there is water, being desirous of getting away. If the bar and the flow be good, numbers get away by half flood, which is an advantage to them, and clears the way for others. As the gates would not be opened till half-flood, vessels could not move out of the harbour so early as they now do, which would be an inconvenience and stoppage, but not, I think, so great, nor likely to be so mischievous, as that of ships entering.

Thirdly.—Mr. Murray considers that there will be little danger of sand collecting behind the gates, as they will be closed when sluicing. Now, even supposing the strong power of the sluices be sufficient for a powerful scour upon the bar, upwards of half a mile from them, I think the sluices alone would not pass the water of land floods, which sometimes come down with great force, filling the whole area, and overpowering the tidal flow even at high water. Then all the gates and sluices must, I think, be open, when the sand brought down by the floods may tend to accumulate behind the gates. Mr. Murray would contrive means of lessening the probability of his gates being prevented from shutting or opening from this cause; but it must be admitted, that what with ships, sand, and ice, an accident to some of the sluices or gates, which would for a time prevent their working, is not improbable; and that if thus or otherwise the water be suddenly let out, and the ships grounded, the damage to them would be greater than at present, as they would not be prepared for grounding, and as ships of a large size, and of a build less suited for taking the ground, would come in, expecting to be kept afloat.

I have stated that the "following" river water is chiefly the resource for restoring the harbour to high water level in two hours after the gates are shut at half ebb. I find that in droughts this will not be nearly sufficient, so that even if Mr. Murray be correct in supposing the water between half-tide level and the top of the gates, when let out through the sluices, to be sufficient for keeping down the bar, *which admits of serious doubts*, it does not appear that a sufficient supply will be had in dry weather for the purpose, when the cubic contents of the pool to be filled are several times that of the river supply.

The tidal water in the upper part of its flow will be drawn downwards and assist, but will do little towards supplying the deficiency.

The last observation is applicable also to the space below the sluices, including that portion of the Potatoe Garth which is to be deepened. I think Mr. Murray over-rates his scouring power when he supposes that it will keep deep water over a space whose sectional area is seven times the area of the sluices, or even if the quantity were by calculation sufficient to give velocity, that it would be uniform over so great a space; the scour in lieu of the sluices would be great at the sides and end of this direct line, there would be eddies, and consequently irregularity of depth, requiring frequent dredging.

When it is considered that the site of the gates is within half a mile of the pier heads in a straight course east and west, and that the width at high water is nowhere less than 300 feet, the swell at present must be very considerable, and the evidence describes it being so, but it takes place after half flood, when the gates will be open. The

means proposed by Mr. Murray, which I have described, would lessen this, but I agree that there would be a rebound from the solid parts of the works, and that there would occasionally be such a swell in the passage up to the gates as would be sufficient to injure vessels and the works if they come in contact.

If the measure were likely to be attended with the success its promoters anticipate, I consider that the value of the wharfage and other property on the banks would be improved, although there might be immediate expense and future difficulty in repairing the wharf walls, many of which are in a miserable state, having been founded before the harbour was deepened. It would be otherwise with the graving and floating docks, and the repairing ways or hards, and some property on the Monkwearmouth side, which would be injured. When, however, the parties have legal or equitable rights, these damages would be matters for compensation, and should not prevent a great public good.

I think the works would cause a deposit in the harbour: therefore, in this respect, I differ from Mr. Murray: but it is proper to add, that deposit is generally a consequence of any artificial enlargement in the channel of a river, that it takes place to an extent in the harbour of Sunderland now, owing to the artificial deepening, and has to be removed by dredging. The quantity and expense of this would, however, be increased by penning the water, and consequently lessening the velocity; but neither would this alone, in my opinion, be a reason for public opposition, were the measure otherwise safe and judicious.

It will be seen by reference to the evidence, that what Mr. Murray estimates at £60,000, Mr. Brooks puts at £200,000; the last is little more than a guess, therefore Mr. Murray is in this respect more to be depended on. I confess, however, that £60,000 is much under what I should have supposed, for the works will be very difficult of execution from the nature of the foundation, and more so from the damage to which, during their progress, the dams and works will be exposed. To execute them properly, without obstructing the passage of shipping, will, to say the least, require much management, and be attended with delay and expense.

I have, &c.

JAMES WALKER.

Great George Street, Westminster,
27th April, 1843.

THE REPORT OF J. M. RENDEL, ESQ., ON MR. MURRAY'S PROPOSED FLOATING HARBOUR, AT SUNDERLAND.

TO THE COMMISSIONERS OF THE RIVER WEAR AND PORT OF SUNDERLAND.

GENTLEMEN,

YOUR wishes that I should be consulted by Mr. Murray (your engineer), on the subject of his plan for improving the river Wear by a half-tide dam, and gates, built across the channel from Thornhill's quay to the Ham Sands, were communicated to me on the 13th of March, and on the 17th and following days I was engaged at Sunderland, in company with Mr. Murray, making such examination of the harbour and river as I deemed a necessary preparative for the required duty.

Since my return from Sunderland, I have had several meetings with Mr. Mylne and Mr. Murray in London, and after a most careful investigation of the plan, I fully concurred in opinion with those gentlemen, that its principle is compatible with the character of the river and harbour, and admirably adapted to the wants of the existing interests of the port—interests so vast as to command the first consideration in any plan for the improvement of the port that can be deemed feasible.

The strongly-expressed opinion in favour of the principle of Mr. Murray's plan, appeared, I presume, sufficient to render unimportant for the time, any difference of opinion as to its details. But in the state of abeyance in which the measure is now placed by the Report of Mr. Walker, and the consequent intimation of the Lord Commissioners of the Admiralty, that they object to the present plan, the alterations in its details, which I am now fully prepared to recommend, should, it is thought, be submitted to their Lordships, and in consequence I now beg to hand you a design or modification of Mr. Murray's plan, which I hope will be made intelligible by the following explanatory Report:—

A comparison of the accompanying design with Mr. Murray's will fully explain the difference in the details of the two plans.

First. I propose to make the outer harbour nearly double the size shown on Mr. Murray's plan, by additions on each side. On the south by setting back the inner half of the present piers in a southerly direction, extending it to the cliffs: and by the excavation of the ground in front of your workshops and engine house. On the north side by the excavation of the Potatoe Garth, including the removal of the old break-water and the western wall of the Wearmouth dock basin.

Secondly. I propose the extension of the float or impounded river along the north shore to the Wearmouth dock, terminating with scouring sluices to the west of its entrance basin, and having communication with it (the Wearmouth dock), by gates of the same width as those at its entrance; the higher or western end of this extension of the float to be made at least 250 feet wide, and its postern end 200 feet; its south side forming a wear of upwards of 1100 feet long, raised to the height of the impounded water, surmounted with wash boards, a gangway above the level of high water, and provided with mooring-posts and rings, and its north side protected with a wall containing ship-ways and all other conveniences for the ship-builder's yards which now line this shore; and,

Thirdly, I propose to construct a dam across the present harbour immediately *below*, instead of above the Ham Sands, with two pairs of gates on the south side of the harbour, each 60 feet wide, and one pair of the same width, and a lock, on the north side, the intermediate or mid-channel space being filled up with scouring sluices.

By this arrangement, the outer harbour will be increased from about 20 to upwards of 40 acres area, the additions being such that vessels may bring up by their anchors on either side of the channel leading to the gates of the inner harbour, or by grounding on a roomy and convenient beach. This anchorage part of the harbour will be five times wider than the channel between the entrance piers, and the heavy inrun of the sea in easterly winds will thus have room to disperse itself. The flood waters of the river and sea will have free vent down the extended float, and over the very long and capacious weir forming its south side. The flood tide, when it rises to the level of the dam, will pass over this extended weir and into the float, without rush or injurious current. The Wearmouth basin and dock will be made an important part of the improved harbour. The property between it and the dam will participate in all the advantages conferred by the float. The power of sluicing and maintaining the depth of the outer harbour, and channel leading from it to the bar, will be greatly increased. Supposing one pair of gates be under repair, there will still be two pairs available to shipping. And lastly, the dam and gates will admit of more easy construction, and the works cause less obstruction to the business of the port during their progress.

There is doubtless room for a difference of opinion as to the extent to which the south pier should be removed and set back; mine is, that it should not be less than shown in the accompanying design, deeming the difference of expense between such a removal and any admissible minor one of little importance, in comparison with the advantages of increased capacity and consequent quiet, with the greater extent of the breaches in this part of the harbour.

Opinions may also differ as to the best position for the dam and gates; my own is, that those works cannot be too near the widened part of the harbour, consequently, if it should be decided that the site I have adopted is too low there, I should say, the proposed widening of the outer harbour should follow the higher position of the dam and gates; this would involve the removal of additional property on each side of the harbour, and would be attended with the loss of the rock foundation which the gates on the south side of the dam, as also the sluices, have the advantage of as now designed. In regard to the width of the float leading to the weir, I beg to remark, that I consider what I have before stated to be *the least* that is admissible.

In explanation of the plan I have only further to observe, that I contemplate the excavation of the Potatoe Garth to the depth of the bar, to which depth it would be easily maintained by the water discharged over the weir, which is co-extensive.

The outer harbour, enlarged as shown on the accompanying plan, would accommodate, without crowd or obstruction to the channel leading to the gates, at least sixty vessels, assuming that some brought up by their anchors, whilst others beached on the new shore opposite the engineer's house, and others on the bank to be formed on the north side of the gates, at the commencement of the weir: such a capacity in the outer harbour, and the absence of a strong current or of broken water through the gates, which the great length of the weir will secure both on the flood and ebb tide, will, I am convinced, prevent all dangers or difficulty in bringing up in the outer harbour, or in passing to and from the inner harbour or float.

In reference to the principle of penning the water in the way proposed, I would remark, that I do not think the river of sufficient magnitude to make its fresh-water deposits a matter of serious apprehension, particularly as all accumulations of that kind will take place at the head of the float near Hilton, where it can be removed at a trifling cost.

Again, as to to the effect on the bar at the harbour's mouth, it must not be overlooked, that by properly contrived and well-applied sluices, the retained water to be discharged during the hour or hour and half of lowest water on the bar, will give a greater scouring power than the last three hours natural ebb, of which it will be deprived: the difference in favour of the former is matter for calculation, and has been made by Mr. Murray. Also, it should be remarked, that at present the indraught of the first half of the flood in spring tides is quite sufficient to charge the water with much sand, and cause its deposit in the higher and wider parts of the harbour. This indraught will not exist after the proposed works are executed for the first half of the flood, which will exclude much of the matter that now accumulates in the harbour, causing a necessity for constant dredging, will lessen the liability of accumulations in the outer harbour, which will, in all probability, have but small occasion for the use of the dredging vessel.

Mr. Mylne, in his clear and very explanatory Report, has gone so fully into the many arguments that can be advanced in favour of the principle and plan, that it becomes unnecessary for me to say any more than that I agree with him therein.

A minute estimate of the probable cost of executing this plan has not been gone into, but if you wish it, the exact quantities of work shall be computed, which, being charged at the same rate as in Mr. Murray's estimate, would of course give the comparative cost of the two plans. I have compared the quantities of work in both in a general way, and find that, exclusive of setting back the South Pier and the gates of communication between the float and the Wearmouth dock, the quantities of work in the two plans very nearly agree; and as their relative difficulties of execution are certainly *not* unfavourable to the modified plan, its *whole* cost cannot be more than £30,000 in excess of Mr. Murray's plan, or say £90,000 exclusive of compensation, the claims for which would certainly be reduced in number, and still more in amount, by the benefits which the modified plan could not fail to confer on the dock and the property from thence to the Ham Sand.

I have the honour to be,
Gentlemen, your most obedient servant,
JAS. M. RENDEL.

8, *Great George Street, Westminster,*
9th May, 1843.

TUNNELS.

The tunnelling upon the Great Western Railway, for the first 20 miles out of Bristol, amounts to nearly 4 miles in length. There are five tunnels on the London and Brighton Railway, amounting in length to 3 miles 76 chains; and this line is only 56½ miles in length. There is a single tunnel upon the Huddersfield and Ashton Canal, 3¾ miles in length, with shafts 800 and 1000 feet deep. The single Summit Tunnel, now executing on the Sheffield and Manchester Line of Railway, exceeds this tunnel in length by 8 chains, and is constructed by sinking 5 shafts, averaging in depth 514 feet, and amounting in all to 2571 feet. I propose executing this tunnel (on the proposed line of the Caledonian Railway,) by sinking 10 shafts, being double the number of those on the Sheffield Line. The average depth of the shafts will be 223½ feet; and the whole shafting, 2236 feet. Thus, the separate shafts on this tunnel will be less than one-half the depth of those on the Sheffield Line; and, by sinking double the number, the depth of shafting will be less by 335 feet. There are nine tunnels proposed on the East Coast Line from Edinburgh to Newcastle, which amount to 2 miles and 52 yards. The expense, in cutting, at the entrance to each of these tunnels, so as to make them as short as possible, is very great indeed. The gradient of the Box Tunnel, 2 miles in length, upon the Great Western, is 1 in 100; the gradient of this proposed tunnel is 1 in 200.

Having shown, by taking the aggregate length of different tunnels upon several lines of railway executed, in progress, and proposed, that they are equal to or exceed this proposed tunnel, the question may be asked, Why is a single long tunnel considered a work of difficulty, whilst numerous small tunnels, however long the aggregate length may be, are not comparatively thought much of? In general, wherever a tunnel is proposed, it is made in preference to open cutting, on account of its being executed more cheaply, the depth of cutting having increased to such an extent that to tunnel would be cheaper than an open cut; and, in general, the longer the tunnel, the higher is the incumbent material above the level of the rails, causing a very great additional expense in sinking shafts, thereby lessening their number, and thus increasing the length of driftway between the shafts; the great depth causes also a greater body of water to flow into the tunnel, to get rid of which is one of the greatest expenses in tunnelling; few shafts being sunk, prolongs the time of execution, thereby causing

the water to be pumped for a long period of time; these, with several other causes, are natural reasons why a long tunnel should cost much more per cubic yard than a short one. Again, the material through which a tunnel has to be cut is a most important matter. In tunnelling through soft material, or through regular seams of rock of small thicknesses, arching is required: the mere cutting out of the material in such cases is done for less than one-half of what a cutting through hard unstratified rock will cost; but an extra opening is required to be cut all round to make room for the lining: in cutting down short lengths for lining, the top, and often the sides, have to be well timbered. In a tunnel having few and deep shafts, and where this is required, the cost per cubic yard comes very high, on account of the want of room for the men to work in with advantage. In a small compass there are combined together, miners, carpenters, bricklayers, masons, and labourers, all in each other's way; masonry, lime, and timber coming into the tunnel for lining, centering, and propping, at the same time that the mining and excavating are going forward. In the other case, where the tunnel requires no lining, although the mere mining per cubic yard costs more, yet, all other things considered, the whole tunnel is executed for nearly one-half of what it would cost if lining were required; thus, Mr. Locke, in estimating the summit tunnel upon the Sheffield and Manchester line, calculated 100,000*l.* as the cost, if through hard material, and 200,000*l.* if through soft and requiring lining. Again, the cost of tunnels must vary according to the size they are made. Several old tunnels upon canals, completed without any towing-path, have been executed for £4 per running yard. The old tunnel upon the Grand Trunk Canal, at Harecastle in Staffordshire, constructed by Brindley, cost only £3 : 10*s.* 8*d.* per running yard; it was 10 feet in diameter, and consisted merely of a semicircular brick arch, which sprung from the water-line of the Canal.—*Mr. Low's Report on the Caledonian Railway.*

REVIEWS.

The Guide to Hayling Island. London: Spencer, 1843.

The condensed topographical histories which are so frequently issuing from the press, are not unimportant contributions to the literature of the country. They are generally written by persons of education, who, from a long residence, have become acquainted with the localities described, and from the cultivation of a habit of observation, are well qualified to represent the scenes with which they are familiar. They seldom contain any profound antiquarian research, but generally point out the objects most worthy of examination. In this they unconsciously perform an important service in the preservation of works of art, and in protecting valuable national or family records. If the various objects of interest in our towns and villages had been described by our forefathers in modest inexpensive duodecimos, and their contents had been made known to the resident populations, we should have had less cause to regret the destruction of so many monuments of former ages. Every association which has for its object the preservation of historical records, would do well to enlist popular favour by increasing popular interest, and in no way can this be so certainly effected as by the distribution of cheap publications, descriptive of antiquarian or architectural objects. It is for this that we feel a peculiar interest in every little sketch, however poor it may be in its execution, however weak in style, or shabby in dress. But the Guide to Hayling Island is one of the best of that class of works to which it belongs, and is illustrated by several wood-cuts very creditably executed.

The Student's Guide to the Practice of Measuring and Valuing Artificers' Works. London: Weale, 1843.

The art of measuring and valuing artificers' works can only be acquired, we are convinced, by long and constant practice. It is not a profession to be learned in the study from books, nor even in the office from drawings—nothing but practice can make a good measurer. A book, however, is not useless, although the Guides, Essays, and Treatises which have hitherto been published are really of little, if of any value. A youth may be well prepared for practical information by studying a good descriptive essay; and many of the disputes which now arise between measurers, and especially when London and country surveyors meet, might be prevented if the rules of practice were well determined and accurately stated in a book acknowledged as an authority by the profession. We speak of an authority, not in the sense of superseding private judgment, or as dictating to the man whose opinions should be unshackled, but merely as determining certain customs, which, when disputed, are necessarily injurious to the parties represented. Such a book would be not less valuable to the man who invests his capital in building speculations than to the tradesman and surveyor.

The work before us has something of this character. It is a great improvement upon all the books which have preceded it on the same subject, and cannot fail to be useful to the student. It is a volume which will be sure to find its way into every office, and if we are not mistaken in our estimate of a number of persons who call themselves mensurers, will be scarcely less useful to principals than to pupils. The subject of the work will be best explained in the author's own words:—

"This treatise was commenced originally for the purpose of giving the pupils studying under the author, who had an extensive country practice, a correct idea of measuring, abstracting, bringing into bill, and valuing the different artificers' works, agreeably to the methods considered by the London surveyors as the most correct and expeditious.

"The great talent and extensive practice of metropolitan surveyors must be allowed as sufficient authority for concluding that the rules laid down by them are superior to any others that can be adopted. Independent of which, it being the practice for the architect, or his clerk or surveyor, to meet the surveyor appointed by the tradesman, to take the dimensions, abstract their contents, make out the quantities into the bill, and value the work together, it is absolutely necessary that a regular system should be adopted, and strictly adhered to, in every part of the business, or much confusion would arise, as is generally the case whenever London surveyors have to meet country practitioners; and it is consequently of the utmost importance to establish the same system throughout the kingdom. The great improvements made in travelling, and the velocity with which we are conveyed, will soon place every part of this country within a few hours' journey from the metropolis; and the natural consequence of these increased facilities of communication must be, that habits and methods of doing business will proportionately assimilate.

It is not intended in this part of the work to explain the method of manufacturing any materials, as bricks, tiles, &c., or the method of performing the respective works, except so far as to enable the young student to describe the work which he is about to measure, and to ascertain if it be executed in a proper and workmanlike manner. But a perfect knowledge of this department can only be obtained by great attention, perseverance, and practice. The method is shown of valuing all the leading articles in each trade, by first ascertaining the fair price to be allowed for the materials, according to the prime cost thereof, and by adopting what the author considers the *ne plus ultra*, viz., a decimal, by which, if correctly ascertained, the amount of labour thereon at all periods may be immediately found by multiplying that decimal by the rate of wages allowed; this is the only method by which perpetual prices can be formed. Materials and labour are continually but not proportionally fluctuating, consequently the value of work can only be determined by first ascertaining the cost of the materials expended, and making the requisite allowance for profit and waste, and then the amount of labour in executing it.

As the tradesman's bill must be passed and signed by the architect,

he prime cost of materials may, in most instances, be obtained without much difficulty, and in all cases may be demanded before he allows the prices charged. The quantities required, per rod, perch, square, or yard, according to the description of work, the architect ought, agreeably to certain rules, to be capable of determining. But many difficulties arise, and the greatest attention is requisite to ascertain correctly the fair average of time to be allowed between the common and best workmen, and also between what men can and what they will do. The decimal must, therefore, be calculated agreeably to our respective judgments, and from the best information we can obtain; the correctness of which depends on the attention we have paid to the subject, and the opportunities we have had of arriving at our conclusion. Those which are now submitted to the public will be found as correct as they can be made in the compilation of a work like the present. It is anticipated that the professional man may, in his advice to the student, be induced to place this subject properly before him, and establish rules by which every description of work may be valued according to the prime cost of materials, and the rate of wages at any time and place when and where the work has been performed."

Having satisfied ourselves of the value of this work, we strongly recommend it to our readers. The information it contains is varied and useful, and it is so arranged as to be available for immediate reference. The plates are well chosen, and will assist the student, who, having once carefully perused the work, will find himself in a condition to derive immediate advantage from the practice into which he is introduced.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

FEB. 6.—William Tite, Esq., in the chair.

A paper was read by Mr. Morris on Ripon Cathedral. The present cathedral was commenced by Archbishop Thurston, soon after his advancement to the see of York (in 1119). The plan was a simple cross, and the style Anglo-Norman, with semicircular and pointed arches promiscuously applied. The walls, as usual in similar buildings, are thick enough to allow galleries or passages to be formed in them. The doors are ornamented with shafts and arched mouldings, in which richness is produced by the repetition of a simple elementary form; and it is worthy of notice, that in the Norman arches the blocks of stone, though moulded or carved in a variety of ways, never wholly lost the original square figure, previously given to them. Without asserting, therefore, that at this period the mouldings and ornaments were actually wrought after the stonework was set, such a disposition of the mouldings would tend very much to simplify that process: and it will further be found, that these ornaments are not unfrequently modified to suit the actual size of the blocks. There is a low central tower with good detail; and immediately under this is a small crypt or cell, with access from the nave, and also from the choir. To what use it was appropriated does not seem very clearly decided, its extreme dreariness suggesting the idea of a penitentiary; and the small recesses in the sides, suitable for the reception of a lamp or crucifix, assisting the notion. It may have served simply as a confessional; but whether intended for the momentary reception, or more perdurable home of the sinner, or the fugitive from the arms of the temporal power, it is evident that the priest entering from the choir could communicate with and not be seen by a person brought down from the nave. For this purpose there was an orifice in the wall that has acquired the name of St. Wilfred's needle, which the more energetic visitors make a point of endeavouring to get through: and the fine polish acquired by its stone in its contact with silk and broadcloth, show that the attempt is pretty generally made with success. Since the completion of the original structure, no building has perhaps undergone such important alterations without a more complete destruction of its individuality.

The transepts, however, bear more legibly than any other portions the impress of the 12th century, but the inner roofs appear never to have been completed. Small shafts suited to support the foot of a groin (revealing a purpose unfulfilled) are carried up (here as in many other instances) story after story, and are at last left without adaptation either to a flat or vaulted ceiling; and thus from the absence of an homogeneous and appropriate inner roof half the effect is lost. How lame and abrupt does the flat ceiling at Peterborough appear to an eye that has dwelt on the masculine vaulting of Durham! The cause of the very few instances of Norman groining remaining, except in crypts, and the fair presumption that not many ever existed, is a subject open to investigation, and a speculative idea may be not without its utility in eliciting satisfactory information. Thick as the walls at that period are known to be, the risk that would have attended charging them with stone ceilings, without the auxiliary resistance of external buttresses, may have become an object of anxiety with the builders, and the execution of such works in stone may have been attended with difficulties which even at this time would be considerable, and may then have proved altogether insurmountable, except under the most favourable circumstance, and amplitude of means. The centering alone, if considered for a moment, is an object involving so considerable an amount of expense and practical skill, that we cannot wonder that even in the best days of the art, methods should have been devised for dispensing with it, and hence doubtlessly arose the adoption of wood at Lincoln, York, and elsewhere. Did not the Norman builders feel and shrink from the difficulty like their successors, but without the good fortune to hit upon so happy an expedient? We know that they affected the groin, from its constant adoption in crypts and ailes, when a moderate span facilitated its execution. As the central tower presented the strongest abutments for an arch of any part of the church, it is possible that a groin existed there similar to that at Lindisfarn, in Northumberland, and causes for its non-existence, at the present time, are by no means deficient. Before leaving the transept we may notice, that on the east side of each there is a chapel of two arches; that in the north transept being nearly coeval with the church, and that in the south of the fourteenth or fifteenth century.

The choir comprised originally three arches only, but was subsequently increased to six. The effect is curious at first, from the circumstance of the triforium arches being filled with tracery and glazed, and the roofs having been lowered. It looks, therefore, like a double clerestory. The addition of the arches appears to have been carefully made to assimilate with the original work, but subsequent alterations bear the characteristic of their own date. In 1319, the church was burnt and greatly injured by the Scots, but restored by the munificence of Edward III., Melton, archbishop of York, and others: and the "steeples" were then added, of which the central one, 40 yards high, was called St. Wilfred's.

There is an old print which shows spires on the central and western towers similar to Lichfield. The former was blown down in 1660, destroying in its fall a part of the south side, of which the reinstatement (said to have been done at the expense of one of the prebendaries) is still perceptible, by the variation in style. After this accident the other spires were removed. In the south aile is a large piscina, probably used for washing the sacerdotal linen, and round the sides and end there was arched-headed panelling, but part of this is now displaced by the altar screen, erected some few years ago from a design by Mr. Blore, under whom also the groined ceiling was restored, in which are preserved the ancient wooden bosses, which are very beautiful. The east window, erroneously said by Rickman to be of five only, consists of seven lights, and is a fine example of the kind. The clear opening is 48 feet high. Sir William de Plumpton was founder of a chantry at the altar of the Holy Trinity behind the high altar. The act of endowment is dated at Ripon on Wednesday, the feast of the conversion of St. Paul, 20 Edward III., 1345, and was sealed with the seals of Henry de Plumpton, the chaplain first appointed thereto, and of Sir William de Plumpton, which bore the impression of a shield, and on it five fusils, with the name written on the circumference. This chantry was screened from the rest of the church, and under lock and key, but no vestige of it remains.

Near the altar on the south side of the choir are three sedilia, and a piscina of curious and elaborate design and skilful execution. The arches are cinquefoiled, the cusps being ornamented with small grotesque heads or other figures, which at the first glance appear to terminate the design; but, on closer inspection, it is found that the small bas-relief first seen is merely the crown of another head in high relief, of a figure falling into bas-relief, and covering the soffit of the arch. These figures have human heads with the bodies of quadrupeds. They are of either sex, and habited in full monastic costume; and the stout friar is regarding, with an expression too energetic to be perfectly platonic, the beautiful, coy, and wimpled nun. Seats of this kind are not of unfrequent occurrence in English cathedrals and other churches, as well as in those of the continent: "at Sens, on the epistle or south side of the high altar are five seats; one for the celebrant (which is highest), two for deacons, and as many for sub-deacons, all officiating while the other priests were in the choir." "One single seat," continues the essayist, (*Clark in the Archæologia,*) "is accounted for by the choir performing the part of sub-deacon, and one priest that of celebrant and deacon. In churches better endowed, besides the celebrant one performed the part of deacon and sub-deacon. In such churches were two seats. Thus the number was proportionate to the richness of the endowment, and the seats intended for the officiating clergy only. The bishops' seats were at the east and by the side of the altar. The choir is rich

ROOF OF CLAPHAM CHURCH

Fig 1

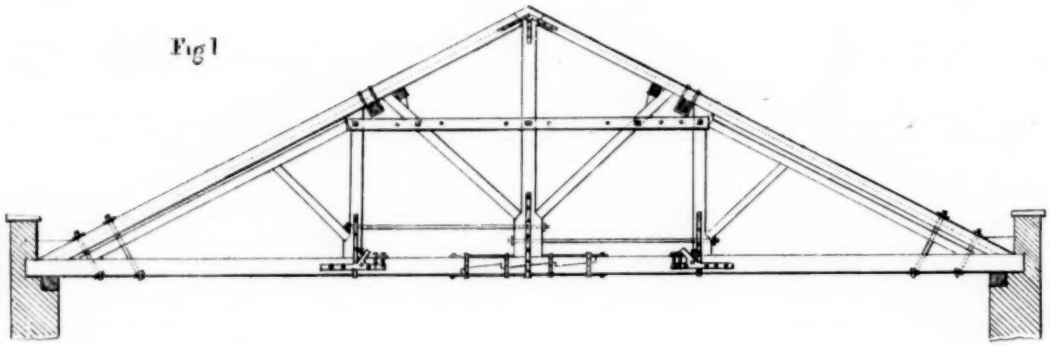
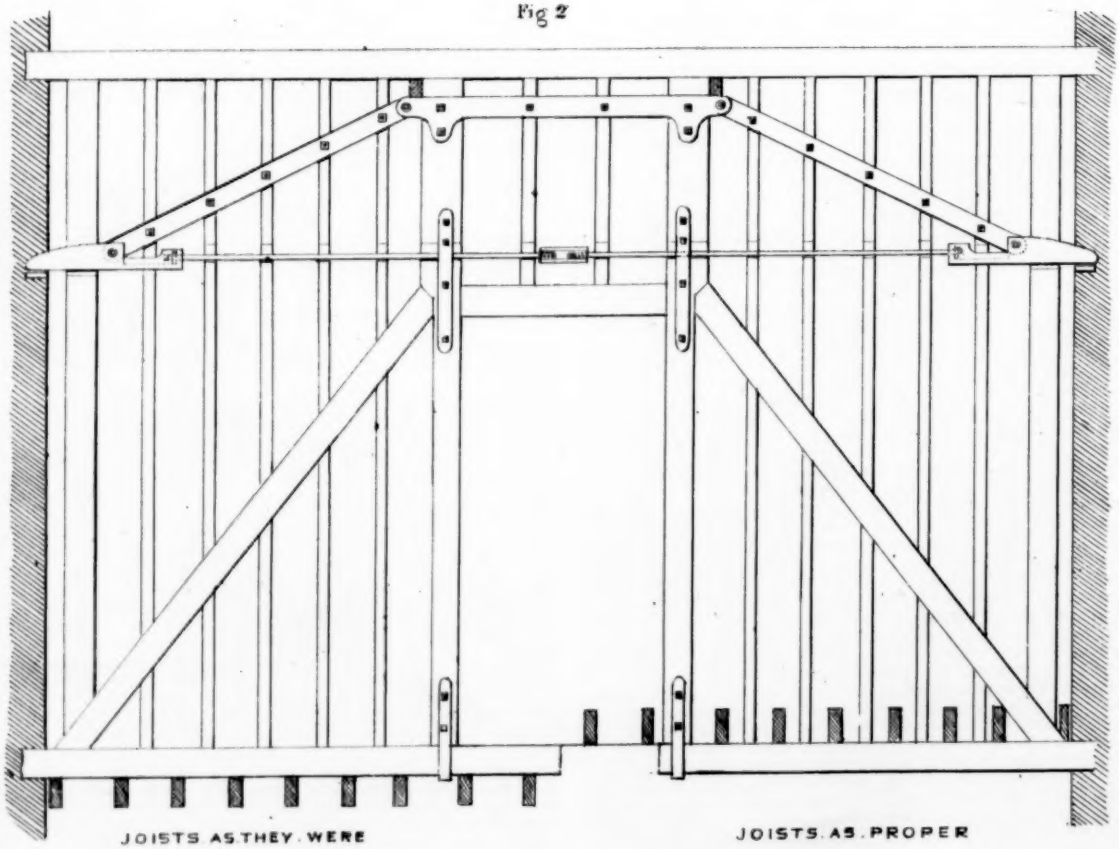


Fig 2



JOISTS AS THEY WERE

JOISTS AS PROPER

T. Faulkner Lith

in carved oakwork. The stalls are furnished with misereres and tabernacle work, (which is said to have formed the model for the new work in the choir of York Minster.) The throne is also an object of interest, as presenting one of the earliest evidences of the architectural attainments of the noble Earl, the President of the Institute of British Architects.

The organ screen is of bold and original character, without pretending to the extreme elaboration of that at York. Adjacent to this stands part of a rich stone pulpit. The central tower has for some generations presented a most singular and heterogeneous spectacle, but at the same time affording to the professional observer a valuable comparative view of the varied proportion and effect of the first and latest eras of true Gothic. In point of expansive lightness, the earlier style is certainly entitled to our admiration, though mass and richness may be exclusively the merit of the latter. Three of the piers of the central tower were cased in the perpendicular period, and the arches of the choir and south transept were also completed; but the fourth pier and the arches of the nave and north transept retain their original form. It is also illustrative of the method pursued to find the perpendicular work carried on the two sides quite up to the battlements. The immense size of the piers, and the increased height of the springing, has the effect of contracting the opening of the arch, and also of rendering it necessary to ramp up the longitudinal crown rib of the groin.

Taking our survey in chronological order, the next point for consideration is the west front, which comprises the end wall of the nave and the two flanking towers, each of which is about 28 feet wide and 112 high. The present termination is not original, the battlements and pinnacles being of much later date. As to the mode in which they were originally finished, it may be difficult to furnish a satisfactory suggestion; but of that which remains it would be still more difficult to convey an adequate impression. The simplicity of its outline, the unbroken massiveness of its general feature, and the rich and effective detail, respectively contribute to the grandeur of an ensemble unsurpassed by any building of its date.

The lower story has three doors into the church, and the second five successive windows extending the whole width of the nave, with a passage in the thickness of the wall. The second stage has an equal number of windows, the heads of which are elevated towards the centre to compose more readily with the gable, which is filled up by a triple window and trefoil panel. The windows are of two lights with trefoil heads and a trefoil in a circle above. Between the windows are piers of several shafts with foliated capitals, and the pierced pyramid or four-leaved rose; and the wall is very thick here to receive the many shafts and deep receding mouldings with which they are charged. The buttresses of the towers are broad and flat, with shafts in square recesses at the quoins, and run the entire height without diminution; the windows (except that some are filled with louvres) corresponding nearly in form and date with those of the central front. It is an interesting circumstance that the progress of almost every change in this edifice can be traced at this moment with no other guide than a little reflection, and with nearly as much clearness as the most circumstantial chronicle could have recounted them. The Norman nave, for instance, is shown to have extended as far westward as the present, from the fact that the builders, in making their addition, left as much of the old work remaining as could be rendered available; and a portion of the old nave has thus been preserved, and the perfect coincidence of the joints of the piers with those of the west wall, show that the formation of the fine arches into the towers from the nave was predetermined in the design of the architect, and not an afterthought, as might on a cursory view be imagined; indeed, it may be noticed that the interiors of these towers were finished with great care, and were intended to be entirely open to view from the floor to the roof, where the walls are terminated by a cornice and corbel-table. The moulded piers and arches of the lower stories are very fine, and become plainer in proportion to their remoteness from the eye. At each story was a gallery of communication, not only round the interior of each tower, but across the front from one tower to another.

I should have noticed, that while the pyramidal flower is abundantly used in the vertical lines and in the arches, the flattened uncut pyramid, usually called the nail head, is adopted with equal constancy in the horizontal bands and dripstones; yet there is not the slightest taint of monotony discernible throughout. Beautiful as the principle of construction here observed must be generally deemed, giving an appearance of the utmost solidity and strength, with a comparatively small amount of material, it is to be regretted that there was a practical disregard of bond, and from the very inconsiderable proportion of horizontal masonry, the towers were divided by the windows into four insulated vertical piers, with no adequate tie to meet the contingency of a tendency to spread at the top. The subtle workings of half a dozen centuries, however, manifest the necessity for a precaution that was not contemplated by the builder.

It is, I think, pretty evident that the primary plan was a simple Latin cross, without ailes. The transepts retain their original form, except that chapels have been erected in the east walls, and arches have been opened into the ailes of the nave; while the continuation of the base-mouldings, and other external decorations of the towers, attest the absence of ailes at the time of their construction. The present nave may be referred to the close of the 14th century, and is a fine masculine example of that date. It has no triforium, but the clerestory windows are large, and have a gallery running through the piers. The wall ribs which exist indicate the purpose and form of groined inner roofs; but it is to be regretted that this part of the design has never been effected; and the external pinnacles were also left in an unfinished state.

Although the interior of this church cannot boast much of the rich garniture of ancient monuments or mortuary reliques, its impressive and venerable aspect cannot fail to call forth our admiration and respect; and the circumstance of its comprising fine decisive portions of the consecutive styles, including Norman and perpendicular, render it an object deserving the careful attention of the architectural student and antiquary.

It only remains to notice a small building on the south of the choir, a lower apartment of which has obtained some celebrity in modern times as the bone-house, from the immense number and symmetrical disposition of the exuviæ of innumerable tenants of yet more circumscribed and darksome chambers, from which they were ejected some half century ago. They are now built in masses like masonry, and exhibit an affecting display, to speak in the language of heraldry, of *morts* and *saltires* argent. (There was a similar instance at Sligo and another at Hythe.) This charnel house has certainly the characteristics of extreme age, and the formation of the vaulting accords with the earlier imitations of classic examples. The apsis at the east, and certain external details also, attest its ancient foundation. Immediately above is an apartment now used as the vestry, but formerly the chapel, to which the part just considered formed the crypt. It is entered from the aile of the choir, and is of a very simple character; vaulted, and retains its ancient piscina. This building has been deemed anterior to the body of the minster; but when we consider the casualties to which, from its position, it would have been subject during the erection of so large a pile immediately contiguous, it will probably be more rational to assign it a contemporary date. May it not have been the Lady chapel, or chancel chapel? of which there is a fine example now used as a school at the west end of Norwich cathedral, with a crypt below; and it may be borne in mind that both Norwich and Ripon are Norman foundations without crypts.

A paper was then read by Mr. Papworth, explaining "the method adopted in 1829 to confine the lateral walls of Trinity Church Clapham."

In the year 1829, the trustees of Trinity Church, finding that settlements had and were occurring in the tower, and great part of the walls, and that large portions of the side walls were overhanging, directed a survey and report to be made to them, of the various facts which presented themselves, with the causes which produced them, and the remedies to be applied; which, after due consideration, were communicated to that board.

The walls of the building were erected about the year 1774; they are of sound and well-executed brickwork, with stone rustic quoins and stone dressings; the floor of the church is supported by arched catacombs, about 8 ft. 6 in. high, seemingly intended for family vaults, but only the portion under the tower and parts under the gallery staircase, have been so employed; the floor of the church is about 18 in. above the highest part of an enclosed area around it, and this area is not used for burial purposes. The soil having been mounded about 12 inches towards the church, from the curb of the iron railing, it results that the excavation for the foundations was about 6 feet beneath the orignal level, the footings being perhaps 18 inches yet lower. The soil at this depth is a good absorbent gravel, on a clay subsoil, but occasionally varying. Until a very few years ago, the common depended on this character of soil for its drainage, and the church has no other; on which, however, it is not necessarily dependent, as its level is understood to be about 80 feet above high water of the Thames at the nearest point of the river.

These circumstances are mentioned in the thought that, although your time is trespassed on by the relation, yet it will be found useful towards a sufficient understanding of the condition of the roof, the walls, and foundations, at the time the repairs were begun.

The brick footings of the walls of the church and tower, were built upon a continuous 4-inch yellow fir planking, containing much resinous matter, and abounding with large knots. In the first instance, the trenches were not dug perfectly level, and the bottom course of brickwork was laid dry, thence much of the trench was, in winter, subject to wet, and at all times to some moisture. In some parts, particularly the north-west angle of the tower and west staircase, the timber was probably never dry: the nature of gravel (absorbing moisture freely,) of course admits damp air, and the timber proportionately subject to the decay common to wood when so circumstanced.

The footings were first examined from the vaults, and the timber beneath the brickwork was found to be in such a pulpy state generally (except at the knots, and closely adjacent fibres), that the walls both of church and tower might really be said entirely to depend on them for support, with the addition of the adhesion of the materials, and the strength contributed by occasional cross walls.

The planking was very soon removed, and York stone steps, and proper underpinning substituted.

Although portions of the church walls, from the parapet down to the plates receiving the gallery floors, were leaning outwards, it was found that all beneath was nearly upright; of course this led to an examination of the ceiling, in which, at about the middle, a wide crack appeared, running from the west toward the east end, but not so far as the altar. For some years before, a settlement having taken place, the roof there had been taken off, and a new one judiciously constructed and substituted, and some underpinning was then done at the same end of the church. On examining the roof (readily accessible from the tower), it appeared that the fissure alluded to, and the overhanging of the walls, was caused by the pressure outward of the principal rafters, and chiefly on the south side of the church. This pressure outward had disjoined the tie-beams (except those of the new part at the east end), all the tie-beams having been in no very judicious manner scarfed in the middle (the church being about 59 feet wide), they had been bound together by slight iron bands, thin iron ties depending on staples at their turned-up ends, and some spikes to restrain the lateral thrust, which force had almost wholly disengaged these contrivances, amply accounting for the effects observed.

The roof is of a mixed character, uniting the king-post and queen-post arrangements, the queens being framed into the upper rafters, and those rafters, the tie-beams, and the king-post, uniting to make a roof independent of the other timbers, the usual straining beam between the heads of the queen posts being omitted.

The disarrangement of the timbers of the roof by settlements common to them, and the displacement caused by the thrusts, made it proper to prepare for the operation of the means adopted for drawing the separated scarfed ends of the tie-beams something closer; it not being intended to give very much further effect to the power contemplated, because it might have produced injury to the entire roof, and to the upper part of the walls, the gutters, and the slating; at least it was considered injudicious to risk so much probable damage.

To make the fabric secure, was the chief object, for though the overhanging of the walls was not very apparent but to a scrutinizing eye, it was the opinion of some practised men that the church ought to be taken down and rebuilt, notwithstanding that the interior of the edifice forms a very spacious, elegant, and well arranged church, though certainly the exterior gives no promise of the beauty within.

The Plate, fig. 1, represents a section of the roof looking west at its tie-beam face, and shows generally the original construction and the appliances.

The object was to prevent a greater separation of the tie-beams at their scarfings, to stop any further thrust to the walls; and it appeared that by drawing the lower ends of the queen-posts nearer to each other, each having a tendency to urge back its moiety of the tie-beam, that much might be done, and at no great expense.

It being found that the queen-post mortices in the tie-beam were far from being filled by the tenants of the queens, and that to draw them much out of the perpendicular might produce a further and serious disarrangement of the timbers above, to keep the queens upright, or nearly so, and therefore nearly parallel to each other, the timbers bolted together through the heads of the queens, through the struts, and through the king-post, acting both ways as straining pieces, were supplied, and next, those iron blockings intended to oppose any movement more than desirable, were carefully fitted and bolted to the tie beam at each queen-post.

The application of the iron rods, having powerfully threaded screws and ample washers and nuts, was of course a matter of easy accomplishment, and when put into operation, there would evidently have been no difficulty in bringing the ends of the timbers into close contact; but, as above stated, there was no wish to effect much more than full security; and they were only drawn together enough to close in part the fissure in the ceiling.

This operation of drawing together the posts might, without due care, have left the tie-beams without any check to their tendency to sag, and it was therefore found proper (at the time the iron blockings were fixed,) to saddle on them straps bolted well through the tie-beams.

Where scarfings of timber so circumstanced must occur in new roofs, perhaps there are no means more suitable than a similar mode of keeping the scarfed ends together.

The authorities of Clapham church, not doubting the stability of the edifice, directed in October last the execution of two additional galleries for about 150 children; when the consequent scaffolding afforded the opportunity of a close examination, and it was very satisfactory to observe that the operation has been completely successful, and that no settlement nor spreading of the roof, nor further overhanging of the walls, have taken place.

The utility of the principle contained in the foregoing description, may be further illustrated by a relation of the method of its application, and the effects produced thereby.

About twenty years ago, some houses of the first class were erected. In the space of three or four years after they had become dilapidated to a very serious extent, partly arising from the shrinkage of the timbers (for all the partitions above the ceiling of the parlour floor were of timber, framed with cills, plates, posts, and braces).

It should be observed that the parlour floor was an undivided apartment.

But perhaps the chief evil arose, not from any malconstruction in the design or execution of the partitions as they were prepared, but from a most unscientific proceeding after they were fixed, consequent on an omission to provide for the well-known requisitions that must arise when the finishings are proceeded with; all may seem right in the carcase, but the architect and builder know that what in framing is perfect in itself, may become most imperfect by the removal of a small part of it. To make the statement in this case clear, it must be understood that the drawing Fig. 2 represents a partition with cill head, posts, and braces, framed sufficiently strong in itself and ample for its duties.

The height of partitions is too often made the exact measurement from the top of the joists below to the underside of the joists above them, and all seems to be right. Men are sent to lay the flooring boards, and they find the sill must be cut out in order to enable them to lay the boards through the doorway opening, or there would remain a stumbling block;—cut out it is, and all the quality of the construction is gone, the sill being the chord opposing the thrusts, and into which chord are framed the filling-in pieces for the plastering; and so the workmen act with every doorway opening in each partition throughout the house.

Every circumstance mentioned combined to give a ruinous appearance to the insides of these houses. The floors were hollow between the party wall 3 or 4 inches; the door dressings were all disarranged, the cornices were broken, the plastering cracked, and the papering torn; the roof sunken, and the gutters rendered ineffective.

As the house could not be allowed to remain long unoccupied, the builder's usual operations could not be permitted; it was therefore determined to resort to some mechanical means to obtain something like an adjustment of the parts, combined with future stability.

The means used were similar in all the cases, differing only as circumstances required; the floors were raised to the original levels short of shrinkages, the partitions and their openings became fairly correct, and the roofs, &c. adjusted. As may be supposed, the needful works were of no inconsiderable magnitude and expense, yet they were very far short of a complete re-edification of the sunken parts. It may be proper to observe that the attic partitions, and consequently the gutter plates and gutters, were first put right, and the works were followed down thence to the girders of the parlour ceiling, each partition being first made secure in itself.

Description.—Iron plates about 18 inches long and 4½ inches wide were placed on the brick walls, as bearers and slipping pieces, and black-leaded to make them the more so.

The resisting irons were placed on them; then the rods and the double and reverse screw block were attached; and, next, the other parts were slightly appended to the wood framing, the plastering being freely cut away to receive them. The head was then firmly bolted to the posts, and the double screw block put into operation; the braces on both sides of the partition would have yielded outward, but were restrained by small clamps.

In proportion to the shortening of the chord line, the iron head and the timbers connected therewith rose, and the sill also, as

straps connect it with the posts. All yielded to the force, and the partitions rose accordingly. The iron work was then bolted to the timbers, and the timbers and the iron truss became adequate to perform the duties desired.

The result, during the twenty-one years, has been satisfactory; no derangement having taken place since. The power and the effect of this contrivance are very great, but it requires care, thought, and a full knowledge of the nature of the buildings to which it is to be applied. It is an application dangerous to trifle with; but the nature of the principle is sufficiently shown by the drawing and the description, and further detail in the matter is needless; for as no two places (except by mere chance), are precisely alike, every youthful architect ought to think for himself, and he will benefit his employers and himself by doing so. The adoption of ready-made scientific formulæ confers no honour on the architect, and they are very unlikely to suit the purpose to which they are applied, indiscriminately. The student at least should try to create the means he thinks will be effective, and test them by similar works that have succeeded; it is an idle mind (unless deluded by worthless recreation) that does not use its own exertions, and satisfy itself how far it is right or wrong by the resources its owner may himself have, or by those abundant means afforded to him by this Institute.

Feb. 20.—T. L. Donaldson, Esq., V.P., in the Chair.

Mr. Godwin read a paper on church building.

Mr. Woolley read a description of Walhalla.

The idea of raising a monument to the great men of Germany, originated with the present king of Bavaria, when he was Crown Prince, and only 20 years of age. It was in 1804, according to the inscription upon the pavement of the temple, that this noble project was first contemplated by the prince; and though delayed and interrupted at that period, and for some years subsequently, by the disturbed state of his country, his design was never abandoned; but, conceived in youthful ardour, has been prosecuted with manly energy and constancy, and at length, in the summer of last year, received completion in the magnificent edifice, the Walhalla, which now adorns the banks of the Danube, at Ratisbon.

The character given to the building by its mythological appellation, is carried out by the sculpture which adorns the interior. The adaptation of the national fables of the early Germans to a building so entirely national in its conception as the Walhalla, is most appropriate, and certainly the most original feature of the design.

Mr. Woolley then proceeded to make some remarks upon the Scandinavian mythology, which had suggested the name given to this building. To the artist this is an almost unexplored region of magnificent and poetic fable, which may challenge competition with any which the ingenuity of man has invented. As an instance, it would be impossible to select a more poetical creation of fiction than that of the Walkyriæ,—those beautiful, but terrible emissaries of Odin, seen by the dying Scandinavian hero only during his last agonies upon the field of battle, and there upholding his courage to the last, and cheering the dark hour of death by visions of the Walhalla, to which they were come to conduct him.

These beautiful and warlike maidens play an important part in the paradise of heroes, and have been accordingly introduced by Klenze in the building under consideration. Their name, Walkyriæ, from two Icelandic words, signifies Choosers of the slain, as Walhalla means the Hall of the slain. The Einheriar—the name given to the future inhabitant of this glorious abode—upon his entrance, was presented by his guardian Walkyria, with his installation cup of mead; Iduna, the goddess of youth, offered him the apples of immortality. The future life of these heroes, notwithstanding this reception, was neither an idle nor peaceable one. Fighting was an indispensable amusement with our forefathers, even in the abodes of bliss.

The pastimes in Walhalla were therefore in accordance with this superstition. In the morning, at the crowing of the golden cock Fiala, the heroes arise with one accord, buckle on their armour and weapons, mount their war steeds, and sally out of the 540 gates of the Walhalla.

They ride to a mighty plain called Odinstun, and here they fight together with all the fury of their mortal days, performing miracles of bravery, until the god Heimdal sounds his horn, upon which their wounds are miraculously healed, and they return amicably to the banquet in Walhalla, the bravest of the day being rewarded with the most distinguished places at the board. Their food consists of swine's flesh, from the hog Sahrimner, which is never consumed, and mead, or hydromel, is supplied by the beautiful Walkyriæ, whose duty it is to attend upon them, the gods and Odin himself being present at the banquet.

It might be wished that the architecture of this splendid building had shared in the spirit of nationality of which in all other respects it is so characteristic; or at least that it had been more original in design. But as far as regards the exterior, it can claim the merit only of being an excellent restoration of the Parthenon; the architect has made more than ample atonement for rejecting the mythology of the Greeks, by most scrupulously following their architectural model. For this want of invention he seems quite willing to hold himself responsible, by stating that, though the Grecian Doric order was recommended, he was left to the free exercise of his judgment in every other respect. I am, notwithstanding, inclined to suspect that the hint given to the competing architects in the original instructions, to the effect, that an imitation of some approved model of antiquity would be preferred to a less beautiful, though more original invention, influenced him more than he chooses to confess.

The enormous substructure of masonry and large "step-like plinths," upon which the temple is elevated, appears to be an injudicious arrangement: it has the effect of making the principal object, the building itself, appear insignificant compared with its subordinate pedestal. The effect must not be judged, however, from a geometrical elevation; for it must be remembered that the building stands upon a considerable eminence, and that the consequent foreshortening, when seen from below, must in a great measure obviate this objection.

The arrangement of the interior is very skilful, and in many respects original. The task of introducing a method of roofing unknown to the Greeks, but designed in the spirit of their architecture, was a difficult one, and is well overcome. The roof is of cast iron, of which the construction is visible, leaving open spaces glazed for the admission of light, and by means of sculpture rendered highly ornamental.

The division of the hall by the projecting masses, or wings, which originate in the necessary support of the roof, is a disposition which produces animation and a play of light and shade, and also increases the apparent extent of the building. These wings boldly projecting from the side walls, break the monotony of the simple parallellogram form of the plan, and always conceal a portion of the busts which occupy the lower range of walls, and which, from their great number and similarity, would otherwise have become wearisome. The upper portion of the side walls is visible the entire length, interrupted only by the beautiful Walkyren caryatides, which form the principal ornament of the interior, and upon which the eye of the spectator first rests.

The temple, exclusive of the substructure, incloses a space of 234 ft. in length, and 107 ft. in breadth, surrounded by fifty-two Doric columns, 31 ft. high, and 5 ft. 10 in. diameter. The internal length, including the opisthodomus, is 171 ft., the breadth 92 ft., and the greatest height 53 ft., 5 in. Height of the lower order, 28 ft. 5 in.; the upper order, 17 ft. 5 in.; and the caryatides, 10ft. 8in.; height of the temple outside to the summit of the pediment, 61 ft. The substructure is 106 ft. high, 236 ft. in breadth, and 425 ft. in depth. From the level of the Danube to the summit of the temple, is 304 feet.

The first large division of the terrace is of Pelasgic construction, and of polygonal blocks of a marble-like limestone; the second division, and likewise the three large step-like landings below the temple, are of the same stone, and formed of regular blocks, but of unequal height and length, as is found in many buildings of the Greeks,—as in the walls of Kalidon, and also in the Theatre of Marcellus in Rome. The columns are 5 ft. 10 in. in diameter, and formed in eleven blocks.

The severe style of the exterior architecture is relieved by the sculpture in the pediments, consisting of highly relieved groups in white marble, from the hand of Schwanthaler, from designs made by the king. The first illustrates the battle in Teutoburger Walde, under the victorious Armenius: the second represents Germany, to whom, after the catastrophe of 1813-14, the representatives of the united forces are presenting the lost provinces.

The site was so chosen that the south end of the temple should present the principal entrance and access for those on foot. In ascending, by means of the different steps and terraces, first to the right and then to the left, the building and prospects of the distant country are presented to the visitor under various and continually changing points of view. Having arrived by 140 steps at the second terrace, a bronze door is seen, which leads to an arched chamber. This chamber is termed the Hall of Expectation, and is intended for the reception of busts of great men still living, from whence, when the occasion arrives, they are removed into the Walhalla itself. Two other flights of steps lead to the pronaos and principal entrance of the temple.

The arrangements of the interior demanded all possible space for

the reception of the busts, and their proper distribution was a leading feature of the design. It was necessary that the busts should be all of equal size, and of the Greek therm form; and also, in order to typify the universal equality of all in Elysium, that they should be placed in rows according to their dates only, without individual distinction.

It was then essential that the monotony of the *coup d' œil* of so many similar sized heads should be got rid of. The construction of the roof, which of course could not be left open like the ancient hypethral temples, and which therefore required supporting beams, sustained by four projecting masses from each longitudinal wall, so as to lessen their span: this form offered the best means of avoiding the objectionable repetition; and it was thus attained, namely, that in a general view along the hall, a large proportion of the busts would be always concealed from the spectator by the projecting architectural masses. At the extreme end is a large gallery, and in each longitudinal wall a passage introduced, both which, during an inauguration or other ceremony, serve for the accommodation of spectators. In designing the building, the architect always had in view the celebration of some solemn and poetic ceremony, as, for instance, that certain periodical national associations should be held, having for a principal object the admission of a new bust, and the solemn inauguration of a new hero to the halls of the Walhalla. On such an occasion, a processional train would ascend the steps to the first terrace; here the inaugural bust would be taken from the Hall of Expectation, which would be appropriately decorated for the occasion, and from thence be borne in procession to the next terrace, and so carried into the temple. Upon opening the great bronze doors, the procession would be received by a chorus of singers, who would remain unseen in the gallery. Spectators would be permitted only in the gallery and passages, and the hall remain consequently quite free for the train, which would proceed in choragic order to the place appointed for the reception of the bust.

It was important that the interior decoration should tend to promote in the spectator the frame of mind which the foregoing ceremony had awakened, and therefore it was the desire of the accomplished founder of the Walhalla, that the aid of rich descriptive sculpture and ornament should be called in as the most effective means of so doing. In the mythology of our forefathers, the Walkyrie were beautiful maidens, whose duty it was to bear dying heroes from the field of battle to the palace of Odin, there to be entertained with never-ending banquets, and to dwell for ever in the paradise of the valiant.

Statues of these beautiful companions of the beatified German heroes, have been employed as caryatides, to avoid the multiplication of severe architectural forms, which are apt to produce mechanical plainness, and also, in order to relieve the monotony produced by so large a number of busts. These Walkyren caryatides, sculptured in marble by L. Schwanthaler, are habited, as near as is known, in the ancient German costume, and are employed to support the cornice and roof. The heroes of the Walhalla are necessarily divided into two classes, namely, those who, from the want of existing portraits, are recorded only by name, and those of whom busts are really extant. To the first of these is allotted the upper division of the inner compartments of the walls, and their names are inscribed in the spaces between the fourteen caryatides. The busts in a double row, partly upon a continued pedestal, partly upon projecting marble bearers, are divided into six classes, over each of which presides a female therm-shaped statue, sculptured by Rauch, and having reference to the class over which she presides.

In order to complete the allegorical sculpture, the interior pediments formed by the horizontal beams, and the sloping roof, are enriched by three sculptured bas-reliefs, in which are represented the three principal epochs of the northern mythology. In the first is seen the giant Ymer, born of the moisture engendered by the hot wind from Muspelheim and the cold mists from Nifelheim, and from his shoulders spring the first human beings, Askar and Embla. Near him are the Lord of Muspelheim, Surtur the god of light and warmth, and Hela the goddess of Nifelheim. Foliage of the ash and elm fill up the angles of the pediment. In the second pediment appear the principal inhabitants of Asgard; Odin with his spear Gugner, and Frigga with her golden spindle, seated upon their throne Lidskjolf; on the right is Thor with his terrible hammer Miolner, striking the Roman eagle to fragments, and Baldur, the youthful god of Eloquence. On the left Braga, the god of wisdom and poetry, with his goddess Iduna, who, like the Greek Hebe in Olympus, presents the heroes of the Walhalla with the golden apples of immortality. The ravens of Odin fill up the angles. The centre of the third pediment is filled with the mighty ash tree Ydrasil, on the summit of which the eagle of Odin spreads his wings. Beneath the roots flows the fountain of wisdom, with which the tree is watered by the three Nornies. In the angles are the squirrels Rotatoskr.

Beneath this, and between the upper and lower orders, is introduced a large bas-relief in eight divisions, which, according to the command of the royal founder of the Walhalla, illustrates the history of the German nation from its earliest period to the introduction of Christianity, and was designed and executed in white marble by Martin von Wagner, in Rome. This admirable work, 224 ft. in length, and 3 ft. 6 in. high, embraces the following eight principal events. 1st. The peopling of Germany by settlers from the east and the Caucasian countries. A mighty train, in long procession, of wild but beautiful forms, preceded by warriors, followed by their wives and children, and closed by shepherds, are represented passing the river Ister, and engaged in subduing the bear and wild boar, the sole inhabitants of the forests of Germany. In the second division is represented the religion and occupations of our ancestors. In the midst a religious ceremony is being solemnized under a large oak, and horses are being offered in sacrifice. Bards are chanting the mysteries of the religious rites; and a troop of young warriors is impatiently awaiting the completion of their shields, which an artist is employed in decorating. The third division represents the political and commercial doings of our ancestors; the choice of a leader, the first council of the chosen king with his people, and the intercourse and commerce of the Phœnicians with the northern nations. In the 4th, 5th, and 6th, are represented the contests between the Germans and the Roman empire. In the 7th, the conquest of Rome by Alaric; and the introduction of Christianity by the fervent preaching of the holy Boniface, in the 8th division, concludes the bas-relief.

Respecting the ornament employed, it may be remarked, that, without abandoning the long sanctioned Greek contour of form, the architect has employed foliage of German growth, assimilating it as far as possible with the Greek character.

As the adoption of classical architecture was expressly enjoined in the instructions for the edifice, it became necessary to follow what is believed to have been the practice of the Greeks, and unite the charm of colour to that of form. But the architect considers that the striking means which the Greeks employed to distinguish the outlines of their mouldings and members, rendered beautiful and necessary beneath the brilliant skies of Greece, on account of the clearness and light of their atmosphere, is not admissible on external architecture in a northern climate. The interior lithochromic decoration is as follows:—in the ceiling, those parts of the metal construction which are visible are entirely gilt. The coffers of the ceiling, as well as the soffit of the beams, are coloured azure, and ornamented with stars of white gold or platina, with which, also, all rosettes, screw heads, and fir cones used in the construction are covered. The mouldings of the coffers and panels are likewise gilt, and ornamented with coloured foliage. The sculpture and ornamental foliage which fill up the pediment-shaped supports of the roof, are pierced and open, and of light form, that they may not appear to overload this essential part of the construction. They are partly of white and gold, and partly coloured after the manner of classic sculpture. The carved members of the cornice of the upper order, which is of white veined marble, is also partly gilt and partly coloured. The frieze is azure, with oak wreaths of bronze gilt. The upper division of the walls is of a reddish brown marble, from the quarries of Oberfranken: the inscription tablets of white marble, the letters of gilt bronze. The Walkyren caryatides, of marble of the Danube, are entirely but very faintly coloured. The parts representing flesh are ivory colour, the hair fair brown, the bear skin mantle entirely gilt, the upper dress bright violet, the under robe white. The plinth upon which the figures stand, is of a warm grey Lumachelli marble; the entire entablature and the long bas-relief, in the frieze, is of white marble, part from Schlanders, part from Carrara. The carved architrave and cornice are brought out in colour and gold, the relief quite white, and the ground of the ornaments in the frieze azure. The lower division of the principal walls, as well as the pilasters and shafts of the columns, are of brownish red marble from Admet, resembling the antique African. The caps and bases of the columns and pilasters are of white marble, ornamented with colour and gold. The carved bearers of the busts, the busts themselves, and the six presiding statues, together with all cantilevers and seats constituting the furniture of the hall, are of white marble, without colour or gilding. As the busts could not with propriety have been coloured, it would have been prejudicial to them to have employed gilding or colouring in the sculpture of which they form a part. The continued pedestal upon which the first row of busts stands, is of a beautiful yellow marble, from Weltenburg, on the Danube; the plinth is white. The architraves of the doors and windows are of white marble, with ornaments of colour and gold. The doors, plated

with bronze externally, are, towards the interior, of maple, with studs, and inlaying of bright red amazanth wood.

The floor consists of a variety of marbles, following in pattern the general plan of the interior, and was worked and polished in the manufactory at Tegernsee. In the centre fields are three tablets, upon which, in black letters upon a white ground, are the following inscriptions:—"Projected in January, 1806; commenced October 18th, 1830; finished October 18th, 1842."

INSTITUTION OF CIVIL ENGINEERS.

Description of a Drawbridge at Bowcombe Creek, near Kingsbridge, Devon. By George Clarisse Dobson, Assoc. Inst. C.E.

This drawbridge spans one of five openings in a stone bridge, built across a navigable branch of Salcombe Harbour; it is in one leaf, 15 feet 9 inches wide, and 32 feet long, from out to out, supported upon a cast-iron shaft, or axle, placed 7 feet 6 inches from the inner end, working in the abutment pier, which is built hollow to receive it, and thus the part within the axle end acts as a counter weight.

To the centre of the end cross-beam of the counter part, a chain is attached, and after passing over cast-iron sheaves in the masonry of the face of the abutment, is coiled on a drum fixed on a horizontal shaft, carrying on one end a pinion, worked by a rack, attached to the piston of the hydraulic press; by this means, motion is given to the shaft and drum, and consequently to the leaf of the bridge. Balance-boxes are hung to the counter-end, by which the shutting is regulated. The struts for supporting the leaf, when raised, are also thrown in and out of their places by a rack and pinion.

The hydraulic press used for opening and closing the bridge, is simple in its construction, and the whole works so easily, that a female can open and close the bridge in about fifteen minutes, without difficulty. The fresh water used for the pump is contained in a cistern beneath, and seldom wants replenishing, as it is returned into the reservoir every time after being used.

The bridge was designed and erected by Mr. J. M. Rendel, about 12 years since, when he was engaged in improving the turnpike road in the south of Devon.

The expense of repairing, oiling, packing, &c., since its erection, has averaged under £7 per annum, including a small salary to a neighbouring millwright for occasional inspection.

The communication is accompanied by a drawing, showing a plan and sectional elevation of the bridge and the machinery.

An Investigation of the Comparative Loss by Friction, in Beam and Direct-action Steam Engines. By William Pole, Assoc. Inst. C.E.

In consequence of the comparatively recent introduction of direct-action steam-engines on board the steam-vessels of the Royal Navy, the attention of engineers has been drawn to the advantages or disadvantages they possess, when viewed in comparison with those constructed with side levers. The object of this paper is to investigate the value of an apparently formidable objection which has been frequently urged against the direct-action engine, namely, "that from the more oblique action, consequent upon the shortness of the connecting rod, the loss by the increase of friction is so considerable as to constitute a serious objection to this form of engine."

After explaining to what extent mathematical analysis is applicable for determining the amount of friction, the paper proceeds to show that it may be satisfactorily used in the present case, as it is only the friction caused by the strain, or load, which is involved in the objection, and this is more adapted for theoretical than experimental determination.

The three general laws of friction, as established by the best experiments, are,

1st. That the friction caused by one solid body rubbing upon another, is independent of the velocity with which the rubbing surface moves.

2nd. It is also independent of the area of the rubbing surface.

3rd. It is proportional to the pressure upon this surface.

From these it will follow, that if the pressure upon a moving body be multiplied by a certain co-efficient of friction, (whose value is dependent upon the nature of the rubbing surface), the product will be the resistance from friction; and this multiplied again into any space the rubbing surface moves through, will give the amount of "power, work, or labouring force," expended in overcoming the friction through that space.

If the pressure upon the moving body be variable throughout its motion, the differential calculus must be employed, but the principle of calculation is still the same.

The paper proceeds to deduce general mathematical expressions for the amount of friction on each bearing of an engine, by finding, first, by ordinary statical rules, the pressure thrown on each particular bearing by a given force applied to the piston, and then combining this with the space through which the rubbing surface moves.

This is done for the beam engine, and for three modifications of the direct-action engine. Equations are also added for the oscillating or vibrating engine, and for an arrangement in which the connecting rod is supposed to be indefinitely lengthened.

The numerical values of the expressions for friction thus found, are then calculated for an engine upon each of these different constructions, supposing them to be similar in all other respects, having the cylinders 66 inches in diameter, with a length of stroke of 6 feet; and the results are shown in a table, distinguishing the friction of every bearing.

From this it appears that as respects the friction caused by the strain, if the beam engine be taken as the standard of comparison—

The vibrating engine	has a gain of	1·1	per cent.
The direct-action engine with slides	„ loss	1·8	„
Ditto with rollers	„ gain	0·8	„
Ditto with a parallel motion	„ gain	1·3	„

This difference being so trifling, it is contended that the objection to the direct-action engine, on the ground of its alleged increased friction, has, when investigated, no adequate foundation.

Mr. Field believed that the paper was correct in its view of the comparative amount of friction of the two kinds of engines. He was of opinion that an excessive allowance for friction had hitherto been generally made in calculating their effective power. It was found practically, that when the pressure upon the piston was about 12 lbs. per square inch, the friction did not amount to more than 1 lb or 1¼lb per square inch. This was easily ascertained by the indicator, when the engine was working without a load, but when loaded, he knew of no accurate experimental mode of showing it.

At the engines of the Blackwall Railway, the experiment had frequently been tried, by casting off all the load, and so regulating the steam, that the engines should make only the regular number of strokes per minute; the result had invariably shown about 1lb per square inch for friction.

Mr. Taylor confirmed the preceding remarks; it had been the custom formerly in large pumping engines to allow one-fifth for friction, but modern practice had shown that this was not necessary, particularly since greater precision had been introduced into the construction of all kinds of machinery.

Mr. Miller agreed that the friction of engines generally had been over-rated; he believed that as a simple comparison of the friction of the main parts of two kinds of engines, the results arrived at in the paper might be received as correct; but there were several other questions which must be considered, if it was intended to establish a general comparison between the beam and the direct-action engines; this, however, he believed, was not the intention of the author.

Mr. Murray contended that the second proposition in the paper, which assumed that "friction was independent of the area of the rubbing surface," although supported by Coulomb and the early experimenters, had been proved by Vince and others to be incorrect: it was natural to suppose that in proportion to the hardness and smoothness of bodies, there would exist a different ratio for the best proportion of surface to weight for every different body; if a surface carrying a given weight was of less than the due area, the surfaces would cut into each other, become rough, and thus increase the friction: on the other hand, if the surfaces were unduly enlarged, there must be a loss from the additional amount of friction caused by the extended surface. He conceived that the calculations in the paper must be affected by the incorrectness of the data upon which they were based.

The simple mode of comparing the beam engine with the direct-action engine appeared to be, to suppose two engines of the same length of stroke and diameter of cylinder; the proportions being good, it would be indifferent whether the power was transmitted through a direct connecting-rod, or through side levers; the cylinders, air-pump, arrangement of parallel motion, &c., being supposed to be alike, the friction of these parts would be alike in all cases, and the comparison would be limited to the parts employed in transmitting the power from the piston-rod cross-head to the crank-pin; both connecting-rods have the same number of bearings, which in both cases travel with friction over nearly the same distances: it is al-

lowed that the bearings of the shorter connecting-rod have a larger amount of friction, and that from the greater angle it assumes, more friction is thrown upon all the bearings of the parallel motion, on account of the greater force required to retain the piston in a vertical position. To counter-balance the increased friction on these parts of the direct-acting engine, allowance must be made in the beam engine, for the friction of the beam centres, and of the top and bottom necks of the side rods. The friction being directly as the distance moved through, and the distance in the side-rod ends being so very small, it follows that the amount of friction must be very trifling. The distance travelled by the beam centres is greater, but it is not of importance, as it is the angular distance due to the vibration of the beam, measured on the circumference of the gudgeon. Under these considerations, Mr. Murray was disposed to give the preference (if any existed) to the side-lever engine.

In a pamphlet published in 1840, by Mr. John Seaward, it is stated that four-fifths of the whole friction of an engine were absorbed by the packings of the piston, and air-pump bucket, by the slide-valves and by the different packings or glands; consequently one-fifth was due to the whole of the necks or bearings throughout the engine. Now, on considering the large proportion of this amount of the friction that is due to the bearings of the main shafts, of the crank-pin, and of the bottom end of the connecting-rod, and of all those other bearings common to both sorts of engines, it must be evident that the total amount of the friction due to those parts in which a difference between the engines exists, must be but a small portion of this one-fifth. Taking one-tenth or ten per cent. of the whole power of an engine, as the amount of power required to overcome the friction of the engine itself, which was allowed to be ample, one-fifth of this would be two per cent., and therefore the degree in which either engine could surpass the other in the amount of friction, could only be, as already stated, a small portion of this two per cent.

In comparing the efficiency of these engines, it would thus appear that neither could be said to possess advantages over the other, as regards friction, in such a degree as to be appreciable in practice, or to render the point of importance, in a choice between the engines; and that if the one kind of engine had advantages over the other, they must arise from other causes than difference in friction.

Having taken this view of the case with a supposed side-lever engine, of the same length of stroke and diameter of cylinder as the direct-action engine, if manufacturers varied in a slight degree from this proportion, it was for the purpose of obtaining a better proportion of stroke and diameter of cylinder, and consequently a better engine than the one supposed to exist for the purpose of making the observations.

Mr. Vignoles looked upon the second proposition assumed by the author, as being overthrown by the results of the experiments of Wood and others, as to the ratio of friction to the area of rubbing surface, and it was well known practically, that the application of various unctuous substances materially altered the amount of the friction. A certain proportion was requisite between the area of the surface exposed to the friction, and the pressure upon it, to bring it within the general law. For practical purposes, he submitted that the law should be received with limitations.

Mr. Gravatt said, that even allowing, for the sake of argument, that the second proposition assumed by the author was incorrect, still as the paper was only a theoretical examination of the comparative friction of those parts of two kinds of engines, which were most subjected to strain, supposing them both to be of similar power and dimensions, equally well-proportioned and constructed, and the same sort of lubrication of the bearings employed, he would contend that the circumstances being equal, equal results would be obtained, and that the conclusions arrived at by the author should be received as correct.

Mr. Pole observed, that the objections brought forward were important, as they referred principally to the fundamental laws of friction.

He would first give some explanation respecting the communication itself.

The investigation was commenced at the request of his late friend Mr. Samuel Seaward; it was originally intended to have especial reference to the Gorgon engine, but had subsequently been extended to others.

The paper, necessarily containing much mathematical reasoning, could only be read in abstract, and might, therefore, have been partially misunderstood, both as to its objects and results.

The object was, not to enter into a discussion of the whole question of the respective merits or defects of beam and direct-action engines, but simply to ascertain the value of the one objection named.

The whole friction of an engine at work with its load upon it, might be divided into two distinct parts. 1st. The friction due to the engine itself, or such as would be produced by the working of the engine, if unloaded. 2nd. The additional friction caused by the strain consequent upon the load; for it must be evident that when the engine had its work upon it, the friction upon the bearings through which the strain passed, must be increased, and additional friction produced, beyond that which would exist when the engine was working without a load. The latter of these alone required to be calculated, and to this, mathematical analysis was more peculiarly adapted. The friction of the engine unloaded, might be ascertained by the indicator, as described by Mr. Field; but, as he had remarked, there was no practical method of finding what was the additional friction when the load was applied; indeed, it would be as difficult to find the latter by experiment as the former by theory.

He then explained the manner in which the amount of friction upon each bearing had been calculated, and engines of different constructions compared with each other. He had adopted precisely the plan suggested by Mr. Murray, namely, by taking engines of the same length of stroke and diameter of cylinder, and in equally good condition. But instead of assuming, as Mr. Murray had done, that there was somewhat more or less friction on any particular bearing, his object had been to ascertain what was its actual value. If it were impossible to measure the pressures, and spaces moved through, an approximation might be received; but since these quantities were ascertainable, it was more satisfactory to obtain results deduced from them.

The conclusions drawn from the paper accorded, however, with Mr. Murray's, viz., that neither construction could be said to possess advantages over the other, in such a degree as to be appreciable in practice, so as to render the point of importance in a choice between them." The difference between Mr. Murray's process and that in the paper, was that what the former only assumed, the latter endeavoured to prove.

Mr. John Seaward's pamphlet on the Gorgon engine had been referred to. The conclusions he there drew, were more favourable to the direct-action engine, but were derived, like Mr. Murray's, merely from approximate consideration, rather than from strict investigation. Mr. Seaward confessed, that the friction caused by the strain was difficult to be calculated, and had therefore contented himself with assuming, that those gudgeons through which the strain passed, had three times as much friction as was due to the others. He also assumed that the friction was proportional to the area of the rubbing surface, a principle which no experiments had ever shown. On these grounds, it was contended that Mr. Seaward's results were open to objection.

Mr. Pole then proceeded to notice the objections urged against the fundamental laws of friction which he had stated, and to give authorities for them.

The first of these had not been questioned since the days of Vince, by whom it was proved; it might therefore be considered as established. With regard to the second and third, it must be noticed that they depended, in some measure, upon each other, for it could be proved that if the third was true, the second must be true also.

The principal experiments which had been made upon the friction of solids, were those by Amontons, in 1699; Coulomb, in 1779; Vince, in 1784; Wood, in 1818; Rennie, in 1828; and Morin, in 1831, 32, and 33.

Amontons was the first who devoted any considerable attention to the subject, and he found that friction was not augmented by an increase of surface, but only by an increase of pressure.

Coulomb's researches were more elaborate, the experiments were on a large scale, and were submitted to a great variety of trials; they fully proved that the friction was proportional to the pressure, and that the extent of surface did not affect it.

These results were further confirmed by the experiments of De la Hire, Ximenes, Boistard, Rondelet, and others.

Mr. George Rennie's experiments were very valuable, as having been conducted on a large scale, and with much care; they were also of a comparatively recent date. The results were conclusive on the point in question, for he found that when the surfaces were to each other as 6·22 : 1, the friction remained the same, and one of the general conclusions he deduced was, "that the amount of friction was as the pressure directly, without regard to surface, time, or velocity."

The last and most extensive series of experiments were those by M. Morin; they were conducted at Metz, by order of the French government, and extended over a period of three years (1831, 1832, and 1833), no expense or trouble having been spared to render them conclusive and satisfactory.

The results were given by Professor Moseley, in his new work on the Mechanical Principles of Engineering. They proved that "the friction of any two surfaces was directly proportioned to the force with which they were pressed perpendicularly together," and that

"the amount of friction was, in every case, wholly independent of the extent of the surfaces of contact."

The before mentioned experiments all agreed, that the friction was proportional to the pressure, and was independent of the extent of surface. In opposition, however, to these, stood the experiments of Professor Vince, of Cambridge, which led him to the conclusion, that the friction increased in a less ratio than the pressure, and that it was not altogether independent of the area of surface. These experiments were probably conducted with care and accuracy; but it was also probable that equal precision had been used in those which proved the contrary; and if this was allowed, the majority of coinciding experiments might, as in all other cases, be safely received in preference to one dissentient. But if the particulars of Professor Vince's experiments were examined, many circumstances appeared, which would render them less worthy of regard than others. It was not shown that he experimented on metals, but that he used pieces of wood, either bare or covered with paper; and the experiments were on a small scale, the moving bodies being at the utmost a few ounces weight: while Coulomb, Rennie, and Morin, had extended their trials to all kinds of materials, and had used considerable weights. Professor Vince himself, although satisfied with the method of conducting his experiments, did not seem equally so with their results, as regarded the influence of surface and pressure, for he had remarked, "that no general rule could be established to determine it, even for the same body."

Quotations were then given from Gregory, Brewster, and others, corroborating this view of the inconclusive and unsatisfactory nature of Vince's experiments.

The law of the influence of pressure and surface upon friction, was occasionally modified by accidental circumstances, two of which might be noticed, as they had been expressly treated of by Rennie and Morin.

1. It was only applicable within the limit of pressure which would not injure and abrade the surfaces; for when heating and undue attrition commenced, it was natural that the law would not hold good. Well-constructed machinery, however, was never supposed to pass this limit, and therefore this cause of irregularity might be rejected in calculation.

2. Another modification was produced by the application of unguents; this was treated of by Mr. Wood, whose experiments showed, that when unguents were introduced, there was a certain area of bearing surface, proportioned to the weight, which was peculiarly favourable as regarded the loss by friction, but that when this area was preserved, the friction was in strict ratio to the pressure.

It could not, however, have been Mr. Wood's intention, from these results, to impugn the applicability of the established general laws to the purposes of calculation, but only to show the existence of modifying circumstances under certain conditions; for the formula he had given, assumed the friction to be as the weight, and had no element in it expressing the area.

Mr. Rennie and M. Morin had also examined the influence of unguents, and had found that their introduction did not materially alter the general laws of friction, but only affected the value of the co-efficient or multiplier to be used in ascertaining its numerical amount.

Having thus brought before the meeting the results of the principal experiments on friction, Mr. Pole concluded by adducing the testimony of writers on mechanics, who, guided by these results, had promulgated the laws deduced from them. He gave quotations from the following authors in corroboration of his views, viz.—Emerson, Playfair, Tredgold, Barlow, Lardner, Farey, De Pambour, Poisson, Pratt, Whewell, and Moseley. With the last-mentioned author Mr. Pole had taken an opportunity of conversing upon the points in question, and the principles adopted in the paper had received the Professor's full approbation, as corresponding with those made use of in his own treatises.

Mr. Vignoles thought that great praise was due to M. Pole, for the research and mathematical reading exhibited in treating the question of comparative friction. In the former remarks he had made, it was not his intention to impugn the accuracy of the abstract proposition, "that friction was independent of the area of bearing surface," any further than to qualify it in its practical application, with the proviso, "that proper proportions were maintained between the area and the pressure, according to the description of mechanism subjected to friction." He therefore desired to consider the question, as to how far in practice one kind of engine varied from the other in the general amount of friction, and to examine how far the areas of the bearing surfaces were in proportion to the insistent weight, caused either by the strain of any angle or by the direct weight, on any of the journals of the moving parts; this inquiry should precede the abstract mathematical investigation. The friction of different substances would not follow the mathematical rule, unless the due proportion between area and pressure was ascertained and observed; these proportions would be very different in heavy machinery, such as marine steam-engines, and the axles of railway carriages. With these qualifications he agreed with the general propositions laid down by Mr. Pole.

Mr. Murray agreed with Professor Vignoles in thinking that the extent of surface in machines materially affected in practice the amount of friction.

He did not mean to advocate the correctness of Professor Vince's experiments, but he would draw attention to the results quoted by Dr. Gregory, in which the difference of Vince's experiments and those of other writers on the subject was attributed to their not taking into account the cohesion of the bodies experimented upon. The experiments were made with inclined planes, which were raised until the bodies began to move, and the amount of friction was then deduced from the angle of inclination that had been given to the plane: from this mode it was contended that no definite laws could be laid down.

Mr. Murray acknowledged that on dry surfaces, within certain limits, the amount of friction was not influenced by the extent of surface; but he contended that in practice, as different kinds of unguents were used, the cohesion arising from the impurity and clamminess of these lubricating substances, must be considered and allowed for.

Major-General Pasley said that when he was quartered at Malta, he tried some experiments on friction, by having a slab of Maltese stone, which resembled the oolite of Bath, rubbed smooth and placed horizontally; other pieces of smooth-faced stone of the same quality, but of different areas, were then attached to a cord which was weighted and passed over a pulley; the weights, which were just sufficient to give motion to the several pieces of stone, were then noted, and it was found that the area of the surface was not important, the friction being directly in proportion to the insistent weight of the stone. He could therefore corroborate Mr. Pole's propositions.

Mr. Farey considered that Mr. Pole had treated the subject of friction so well, and had selected his authories in such a manner, as to establise his position incontrovertibly; he would therefore only remark, that in collating the friction experiments for his work from Dr. Gregory and others, he had in a measure rejected those of Vince, as being on too small a scale, and not of sufficient importance to rely upon as authority.

It must be admitted, that viewing the question practically, there were circumstances which would influence the proposition. If the surface of a journal was so small as to drive out the unguent, or to cut into the lower bearing, the friction would be unduly increased, and the theoretical position would no longer hold good. The use of unguents would not interfere with the general proposition, although in practice, any substance used for lubrication, which, when cold, solidified and became adhesive, might, for a time, produce an increase of friction; this of course would be avoided, but it would not bear upon the general question.

Mr. Rennie corroborated the position assumed by Mr. Pole, "that friction was independent of the extent of the rubbing surface:" his experiments, which had been tried on a large scale, and with various substances, gave uniformly this result, within the limits of abrasion; when that commenced, the bearings heated and there was an end of the theoretical position. The texture also of the rubbing surfaces altered the condition; for instance, any light body covered with cloth opposed a considerable resistance by the friction of the raised nap; but if the body was weighted, it again came within the limits of the law, because it more nearly resembled hard substances, which alone were considered in theory. Hard and soft woods varied, of course, in the same manner. The friction upon each other of metals of different degrees of hardness, caused in practice some little variation, but it was so slight, that the rule quoted might be safely received as correct.

Mr. Davison stated that he some time ago made several practical experiments with an Indicator, constructed by Messrs. Maudslay and Field, for the purpose of ascertaining the power required to drive various kinds of machinery, in Messrs. Truman, Hanbury, Buxton, and Co.'s Brewery.

1st. He found, that an engine which indicated 50 horses power when fully loaded, showed, after the load and the whole of the machinery was thrown off, 5 horses, or one-tenth of the whole power.

2nd. 190 feet of horizontal, and 80 feet of upright shafting, with 34 bearings, whose superficial area was 3300 square inches, together with 11 pair of spur and bevel wheels, varying from 2 feet to 9 feet in diameter, required a power equal to 7·65 horses.

3rd. A set of three-throw pumps, 6 inches in diameter, pumping 120 barrels per hour, to a height of 165 feet, = 4·7 horses.

By the usual mode of calculation, (viz., 33,000 lb. lifted 1 foot high per minute,) it would appear that there was, in this case, friction to the extent of 13 per cent.

4th. A similar set of three-throw pumps, 6 inches in diameter, pumping 160 barrels per hour, to a height of 140 feet, = 6·2 horses.

By the same mode of calculation as before, there was here, friction to the extent of 15 per cent.

5th. A set of three-throw pumps, 5 inches in diameter, raising 80 barrels per hour, to a height of 54 feet, = 1 horse.

By calculation as before, the friction amounted to 12½ per cent.

6th. A set of three-throw "starting" pumps, pumping 250 barrels of beer per hour, to a height of 48 feet, = 4·87 horses.

By calculation as before, the friction amounted to 15½ per cent.

7th. Two pair of iron rollers and an elevator, grinding and raising 40 quarters of malt per hour, = 8·5 horses.

8th. An ale-mashing machine, made by "Haigh," of Dublin; mashing at the time, 100 quarters of malt, = 5·68 horses.

9th. Two porter-mashing machines, made by "Moreland," mashing at the time, 250 quarters of malt, = 10·8 horses.

10th. 95 feet of horizontal "Archimedes screw," 15 inches diameter, and an elevator, conveying 40 quarters of malt per hour, to a height of 65 feet, = 3·13 horses.

Mr. Davison promised to continue these experiments, and to communicate the results to the Institution.

CORRESPONDENCE AND MISCELLANEOUS INFORMATION.

TO THE EDITOR.

SIR,—YOUR correspondent A.A. has in your last Number some remarks respecting the Church Architectural Societies, in which most persons must agree, mixed up, however, with others which cannot so readily be acquiesced in. Surely even A. A. must confess that it is very possible for such societies to go too far, and subject themselves to the caution which Thos. Johnson, Esq., was induced to give at a meeting of the Lichfield Society, on the 5th January last, "*Ne sutor ultra crepidam*," especially when they, consisting as they do of such a body of clergymen, and clergymen who so clearly, if we may judge by their writings and reports (for they are always the most active members), attach much more importance to the external forms and ceremonies of worship, dresses, and postures, than is consistent with true Christianity—not only make it a *sine quâ non* that future churches shall be built in every respect according to Roman Catholic models, but, the better to insure this, patronize above all others, and even employ, or do their utmost to ensure if possible the employment of architects who will unscrupulously yield to their dictation, to the exclusion of all others, however capable they may be.

It certainly is in the power of such societies to benefit church architecture, and they have done it, by encouraging a proper attention to the mode of designing and altering or repairing churches, and discouraging ignorant and careless persons from meddling with ecclesiastical buildings; but it is impossible that they, at least the clerical members of those societies, can find time to acquire the qualifications for further interference, or, if acquired, duly carry them out, without wholly neglecting their own peculiar duties as pastors, which, if rightly performed, would leave not a moment for secular avocations of even the most commonplace kind, much less for so important and difficult a task to perform rightly as architecture is in any shape; and it is not only highly inconsistent on their parts, but injurious to true religion, for them to interfere to the extent they do, in matters so foreign to their duties, while so many persons, educated for that very service, are both ready and competent to perform all that can be required.

I lament no less than A.A. the injuries and mutilations that church architecture has sustained from the employment of improper persons, either in the place of architects, or from those who have assumed the title on the ground of being able to make or copy architectural drawings, and thereby perhaps quite sincerely and innocently supposed themselves capable of designing also; here then lies all the evils to be remedied, for, so long as there continues to be no such restraint on these aspirants after fame as the other professions enjoy, so long will there continue to be perpetrated such abortions in architecture as are already too rife in this country.

It is singularly unfortunate for us Protestants, if, as A. A. thinks, it is absolutely necessary that we should make ourselves conversan with the feelings and motives which governed those who erected our churches when English architecture flourished, for we could not consistently act on this, without making them, as it were, our own by becoming Roman Catholics. Happily, however, it is not necessary to think as Roman Catholics in order to design Protestant churches, and unless the unfortunate tendency of the clergy towards Puseyism stand in the way, we may yet have churches fit for christians to worship in, which shall also be excellent specimens of architecture, and withal more appropriate than any the Diocesan societies would erect, without bearing any further resemblance to "Dissenting Meeting Houses," than being fitted to receive an assembly of Christians equally opposed to the superstitious vanities which the tractarians would introduce, in violation of the simplicity of the gospel precepts and demands.

A LOOKER ON.

COLLIERY EXPLOSION NEAR SUNDERLAND.—On Friday, 5th of May, an explosion took place in the South Hetton Pit, near Hanswell, about six miles from Sunderland. Three men were killed, and thirteen were seriously injured. The explosion is attributed to one of the doors being left open by a trapper. The continued employment of these boys in a duty upon which the life of so many industrious men entirely depends, after the many warnings and censures which have been expressed by men of science and practical observation, cannot be too severely condemned.

UNIVERSITY OF OXFORD.—Important alterations are to be made in some of the colleges in this university. Baliol is to undergo thorough repair, the direction of which was intrusted to Mr. Pugin, the celebrated Catholic architect. The master of the college objected to the employment of this gentleman, and Mr. Pugin's engagement is consequently broken off. St. John's and All Souls colleges will also receive decorations during the course of the summer; and some new buildings are to be added to University College. The dirt, which has been accumulating for many years, covers many beautiful specimens of art in the respective colleges, the existence of which is scarcely known.

PAYNE'S PROCESS FOR PRESERVING TIMBER.—Although we are prevented from giving in this Number a full description of Mr. Payne's valuable process for the preservation of timber, we are anxious to call the attention of our readers to the subject. The process consists in injecting metallic solutions into woody fibre, which not only renders all kinds of wood more permanent, but also brings them into a state in which they are incombustible. In our next Number we intend to give a full report of this important invention.

RESTORATION.—On the Continent, from Cologne downwards, the work of restoration has begun; and England was even beforehand in setting an example. Canterbury, York, Hereford, Wells, Norwich, Salisbury, Lichfield, Chichester, and Chester, are already undergoing, or are about to undergo, extensive repairs; besides Westminster, Beverley, St. Mary Redcliffe, and others of our minsters; and parish churches without number. With all this, the general taste must be improving, and a false step made now will before long be obvious to all; and besides having (if possible) to be undone, will render any who have been concerned in taking it amenable to the just indignation of posterity.—*Ecclesiologist.*

The Bishop of Salisbury has undertaken to restore, at his own expense, the beautiful chapter-house of his cathedral; the cost will not be less than £2,000.—*Archæological Mag.*

MALACHITE.—A most beautiful specimen of botryoidal malachite, from Siberia, may now be seen at the establishment of Mr. Tennant, the mineralogist, in the Strand. It is about twenty inches in diameter, finely polished, and the colour and figure is, for the unusual size, most perfect. We are informed that, in the year 1808, £300 was offered for this unique specimen of the mineral world; but, whatever sum may now be fixed as its value, it would certainly add a lustre to any cabinet in the world.

THE IRON TRADE.—The total number of blast-furnaces in Great Britain, for the year ending January, 1843, was, in blast, 339, and out of blast 190, whilst the annual produce, taken at fifty weeks, amounted to 1,210,000 tons of crude iron. There were made 3000 tons at the Forest of Dean; in South Wales, 457,350; in North Wales, 19,750; in Northumberland, 25,750; in Yorkshire, 42,000; in Derbyshire, 25,750; in North Staffordshire, 21,750; in South Staffordshire, 300,250; in Shropshire, 76,200; and in Scotland, 238,550.

CALEDONIAN RAILWAY.—Mr. Low has recently made a very important report upon the Caledonian Railway, in which he has proposed certain improvements well worthy of attention. It is a document of great value, both as regards the contemplated line of Railway and the commercial relations of the district through which it

will pass. Without entering at present into any minute examination of the plans proposed by Mr. Low, it may be stated that Mr. Locke's estimate for the deposited line is £17,356 per mile, and the proposed line can be constructed, including a long tunnel, at the same price, but with a saving of more than seven miles in length.

COMPETITION DESIGNS FOR A CHURCH AT TORQUAY.—We are informed by a correspondent that thirty-six designs were sent in for the proposed new church at Torquay. Some were coloured, some tinted, and others were in line. From these, five were selected by the Church Committee, but they were all sent to the Exeter Diocesan Architectural Society, and one of the five was chosen—that by Salvin. Some alterations however were recommended. It was the only one in which a view of the locality was introduced in perspective. Mr. Salvin, we are informed, is the favourite artist of the Camden Society, and furnished the design which the Bishop of Jerusalem took with him.

ECCLESIASTICAL ARCHITECTURE.—The new churches at Roehampton, Wimbledon, Hanwell, and St. Paul's, Wilton Place, proclaim a new era in church architecture. The last-named edifice it is reported will be consecrated on the 1st of next month, by the Bishop of London. The interior is very striking. The roof, reading-desk and pulpit display some of the most choice specimens of modern carpentry: the chancel is deep and well-proportioned, but want of adequate funds has prevented its completion for the present, which certainly, considering the opulence of the neighbourhood, ought not to be the case. It is but just to add, that many have acted with becoming liberality, and that the Marquis of Westminster has presented 500*l.* towards defraying the expense of the new organ. The most beautiful ornament to the church is the font, a present from the Rev. D.A. Beaufort to the new incumbent, to whom he was curate. The workmanship and taste are exquisite. We also mention with pleasure that some of the very best seats in the church are provided for the aged *poor*, close by the eagle desk and pulpit, where they can both hear and see.—*The Builder.*

HOLY TRINITY, BROMPTON.—On Palm Sunday, the beautiful new chancel and eastern window of this church were uncovered for the first time. The stained glass in the new window is by Warrington, and is designed to illustrate the service for Trinity Sunday. The window is a triple lancet, and the centre opening has reference to the lessons for Trinity Sunday, the side openings to the gospel and epistle. We regard this window as one of Mr. Warrington's most successful efforts. The effect of the new chancel and window is admirable, although the view is somewhat obstructed by the present position of the pulpit and reading-desk, which we have no doubt, from the good taste already displayed, will soon be put in their proper place, clear of the chancel arch. The new side windows are very substantial and good, but it will require a large expenditure to complete the necessary repairs of this church, and to give any thing approaching an ecclesiastical appearance to its most unsightly exterior.

COST OF RAILWAYS.—The following is a comparative return of the length and cost of construction of the following railway lines:—

Designation.	Length.	Cost.
Birmingham and Derby	38¾	£1,030,000
Birmingham and Gloucester	55	1,329,300
Canterbury and Whitstable	6	80,000
Dublin and Kingstown	6	303,724
Edinburgh and Glasgow	46	1,200,000
Great Northern	45	1,300,000
Great Western	117½	4,508,160
Hull and Selby	8½	369,589
Leeds and Selby	20	340,000
Liverpool and Manchester	30½	1,407,172
London and Birmingham	112½	5,698,375
London and Blackwall	3½	643,343
London and Brighton	42½	1,300,000
London and Croydon	8½	615,159
London and Greenwich	3½	668,280
London and South Western	76½	2,054,386
Manchester and Birmingham	29½	895,914
Manchester and Leeds	49½	2,113,968
Midland Counties	57½	1,257,811
South Eastern	69	1,850,000

LIST OF PATENTS.

SIX MONTHS FOR ENROLMENT.

Nicholas Henri Jean Francois, Compte de Crouy, of the Edgeware-road, Middlesex, for "certain improvements in rotary pumps and rotary steam-engines"—Sealed March 25.

Robert Faraday, of Wardour-street, Soho, gas-fitter, for "improvements in ventilating gas-burners, and burners for consuming oil, tallow, or other matters," being a communication.—Sealed March 25.

Sir Samuel Brown, knt., of Blackheath, commander in Her Majesty's navy, for "improvements in the construction of breakwaters, and in constructing and erecting lighthouses and beacons, fixed and floating, and in apparatus connected therewith, and also in anchors for mooring the same, which are applicable to ships or vessels." Sealed March 27.

John Sylvester, of Great Russell-street, Middlesex, engineer, for "certain improvements in producing ornamental surfaces on or with iron, applicable in the manufacture of stoves and other uses, and for improvements in modifying the transmission of heat."—Sealed March 28.

Arthur Dunn, of Rotherhithe, soap-boiler, for "improvements in treating, purifying, and bleaching fatty matters."—Sealed March 28.

James Fletcher, foreman at the works of Messrs. W. Collier and Co., engineers, for "certain improvements in machinery or apparatus for spinning cotton and other fibrous substances." Sealed March 30.

Frank Hills, of Deptford, manufacturing chemist, for "certain improvements in steam-boilers or generators, and in locomotive carriages."—Sealed March 30.

Paul Provost Brouillet, of Hadley, Middlesex, gent., for "certain improvements in apparatus for warming apartments."—Sealed March 30.

John Aston, of Birmingham, and William Elliott, of the same place, button manufacturers, for "improvements in the manufacture of covered buttons."—Sealed April 4.

Joseph Browne Wilkes, of Chesterfield Park, Essex, esq., for "improvements in treating oils obtained from certain vegetable matters."—Sealed April 4.

George Johnston Young, of Bostock-street, Old Gravel-lane, Wapping, engineer, for "improvements in the construction of capstans."—Sealed April 5.

Edwin Whele, of Walsall, Stafford, for "an improvement or improvements in machinery for preparing wicks used in the making of candles."—Sealed April 6.

James Boydell, jun., of Oak Farm iron-works, near Dudley, iron-master, for "improvements in manufacturing bars of iron with other metals."—Sealed April 7.

Robert Hawthorne and William Hawthorne, of the town of Newcastle-on-Tyne, civil engineers, for "certain improvements in locomotive engines, parts of which are applicable to other steam-engines."—Sealed April 7.

John Michell, of Calenick, Cornwall, for "improvements in extracting copper, iron, lead, bismuth, and other metals or minerals from tin ore."—Sealed April 11.

James Napier, of Hoxton, Middlesex, dyer, for "improvements in preparing or treating fabrics made of fibrous materials, for covering roofs and the bottoms of ships and vessels and other surfaces, and for other uses."—Sealed April 11.

Moses Poole, of Lincoln's-inn, gent., for "improvements in the manufacture of ornamented lace or net," being a communication.—Sealed April 11.

Uriah Clarke, of Leicester, dyer, for "improvements in the manufacture of narrow elastic and non-elastic fabrics of fibrous materials."—Sealed April 11.

William Tindall, of Cornhill, ship-owner, for "certain improvements in the manufacture of candles."—Sealed April 11.

William Ranwell, of Bowling Green-row, Woolwich, artist, for "improvements in machinery or apparatus for registering or indicating the number of persons which enter any description of carriage, house, room, chamber, or place, and also the number of passengers and carriages that pass along a bridge, road, or way." Sealed April 13.

William Henry Smith, of Fitzroy-square, civil engineer, for "certain improvements in the construction and manufacture of gloves, mitts, and cuffs, and in fastenings for the same, which may be applied to articles of dress generally."—Sealed April 19.

Charles Tayleur, and James Frederick Dupre, of the Vulcan Foundry, Lancaster, engineers, and Henry Dubs, also of the Vulcan

Foundry, engineer, for "certain improvements in boilers."—Sealed April 19.

James Byrom, of Liverpool, engineer, for "an improved system of connexion for working the cranks of what are commonly called direct action steam-engines."—Sealed April 19.

Carl Ludewick Farwig, of Henrietta-street, Covent Garden, tin-plate worker, for "certain improvements in gas-meters."—Sealed April 19.

John George Bodmer, of Manchester, engineer, for "certain improvements in locomotive steam-engines and carriages to be used upon railways, in marine engines and vessels, and in the apparatus for propelling the same, and also in stationary engines, and in apparatus to be connected therewith for pumping water, raising bodies, and for blowing or exhausting air."—Sealed April 20.

John Rand, of Howland-street, Fitzroy-square, artist, for "improvements in the manufacture of tin and other soft metal tubes."—Sealed April 20.

Edward Cobbold, of Melford, Suffolk, master of arts, clerk, for "certain improvements in the means of supporting, sustaining, and propelling human and other bodies on and in the water."—Sealed April 20.

Thomas Oram, of Lewisham, Kent, patent fuel manufacturer, and Ferdinand Charles Warlich, of Cecil-street, gentleman, for "improvements in the manufacture of fuel, and in machinery for manufacturing fuel."—Sealed April 20.

James Johnston, of Willow-park, Greenock, esq., for "improvements in the construction of steam boilers, and machinery for propelling vessels."—Sealed April 20.

Richard Prosser, of Birmingham, civil engineer, and Job Cutler, of the same place, civil engineer, for "improvements in pipes and bars, and in the application of such pipes and bars to various purposes."—Sealed April 20.

John M'Tunes, of Liverpool, manufacturing-chemist, for "certain improvements in funnels for conducting liquids into vessels."—Sealed April 20.

Francois Constant Magloire Violette, of Leicester-square, Middlesex, late advocate, for "improvements for warming the interior of railroad and other carriages," being a communication.—Sealed April 22.

Richard Greville Pigot, of Old Cavendish-street, gentleman, for "improved apparatus for supporting the human body when immersed in water, for the purpose of preventing drowning."—Sealed April 25.

James Moon, of Milman-street, Bedford-row, surveyor, for "improvements in the manufacture of bricks to be used in the construction of chimneys and flues."—Sealed April 25.

William Brockedon, of Devonshire-steet, Queen's-square, Middlesex, gentleman, for "improvements in the manufacture of wadding for fire arms."—Sealed April 25.

William Mayo, of Lower Clapton, Middlesex, and John Warmington, of Wandsworth-road, Surrey, gentlemen, for "improvements in the manufacture of aerated liquors, and in vessels used for containing aerated liquors," being a communication.—Sealed April 25.

Charles Forster Cotterill, of Walsall, Stafford, merchant, for "certain improvements in the progressive manufacture of grain into flour or meal, the whole or part, or parts of which improvements may be applied to the ordinary method of manufacture."—Sealed April 27.

John Winspear, of Liverpool, ship-smith, for "an improved mode of reefing certain sails of ships, and other vessels."—Sealed April 27.

James Stewart, of 3, Gloucester Crescent, St. Pancras, pianoforte-maker, and Thomas Lambert, of 81, Albany-street, St. Pancras, pianoforte-maker, for "improvements in the action of pianofortes."—Sealed April 29.

Moses Poole, of Lincoln's Inn, gentleman, for "improvements in making decoctions of coffee and other matters," being a communication.—Sealed April 29.

James Hesford, of Great Bolton, Lancaster, mill-wright, for "improvements in the manufacture of certain bowls and rolls."—Sealed May 2.

Josiah Longmore, of Regent-street, Kennington, silversmith, for "certain improvements in pens, pen-holders, and pencil-cases, part of which improvements are applicable to other useful purposes."—Sealed May 4.

Edward Morewood, of Thornbridge, Derby, merchant, and George Rogers, of Chelsea, gentleman, for "improved processes for coating metals."—Sealed May 4.

Francis Daniel, of Camborne, Cornwall, assay master and analytical chemist, and Thomas Hutchinson, of Rosewarne, in the same county, esquire, for "certain methods of obtaining or manufacturing lime from a substance or substances not hitherto made use of for that purpose."—Sealed May 4.

John Turnbull, of Holywell Mount, Shoreditch, card-maker, for "improvements in the manufacture of horse-shoes."—Sealed May 6.

James Roose, of Wednesbury, Stafford, for "an improvement or improvements in the mode or method of manufacturing welded iron tubes."—Sealed May 9.

William Edward Newton, of Chancery-lane, civil engineer, for "certain improvements in the construction of boxes for the axles or axletrees of locomotive engines and carriages, and for the bearings or journals of machinery in general, and also improvements in oiling or lubricating the same," being a communication.—Sealed May 15.

John Tappan, of Fitzroy-square, gentleman, for "certain improvements in machinery for preparing and spinning hemp and such other fibrous materials as the same is applicable to," being a communication.—Sealed May 15.

Robert Alexander Kennedy, of Manchester, cotton-spinner, for "certain improvements in machinery for grinding and sharpening cards used in carding cotton or other fibrous material."—Sealed May 15.

John Lucena Ross Kettle, of Upper Seymour-street, Portman-square, esquire, and William Prosser, junior, of Shaftesbury-terrace, Pimlico, gentleman, for "improvements in the construction of roads, and in carriages to run thereon."—Sealed May 16.

Joseph Burch, of the City-road, engineer and machinist, for "certain improvements in machinery for printing on cotton, silk, woollen, paper, oil-cloth, and other fabrics and materials, and certain apparatus to be used in preparing the moulds and casting surfaces for printing, and for certain modes of preparing surfaces previous to the design being delineated upon them."—Sealed May 16.

William Mills, of Foster-lane, glove-manufacturer, for "improvements in fastenings for gloves and other wearing apparel, and in the mode of attaching the same."—Sealed May 16.

John Thompson, of Albury, near Guilford, doctor of medicine, for "certain improvements in bedsteads and couches for invalids."—Sealed May 16.

Joseph Mazzini, of King's-road, Chelsea, gentleman, for "improvements in typographical printing, combining the advantages of moveable types with the stereotype process, by substituting for distribution a special fount for each new work, by means of a pneumatic machine for casting, and a uniplane machine for composing," being a communication.—Sealed May 16.

John Winter Walter, of Stoke under Ham, Somerset, glove manufacturer, for "improvements in the manufacture of gloves."—Sealed May 16.

Robert Walker, jun., of Glasgow, merchant, for certain "improvements in propelling ships and boats."—Sealed May 18.

Charles Maurice Elizee Sautter, of Austin-friars, London, gent., for "improvements in the manufacture of borax."—Sealed May 22.

Christopher Nickels, of York-road, Lambeth, gentleman, for "improvements in the manufacture of fabrics made by lace machinery."—Sealed May 22.

Alfred Poole, of Mornington Place, Camberwell-New-Road, for "improvements in drying malt and grain."—Sealed May 25.

Moses Poole, of Lincoln's inn, gentleman, for "improvements in the deposition of certain metals, and in apparatus connected therewith," being a communication.—Sealed May 25.

John Gillett, of Brailso, Warwick, farmer, for "an improved machine or apparatus for cutting or boring ricks."—Sealed May 25.

John Bushby Gibson, of Nantwich, Chester, esq., for "certain improvements in the manufacture of salt."—Sealed May 25,

Elijah Galloway, of Seymour-street, Euston-square, civil engineer, for "certain improvements in the machinery for propelling ships and other vessels."—Sealed May 25.

Alexander Bain, of 326, Oxford Street, mechanist, for "certain improvements in producing and regulating electric currents, and improvements in electric time-pieces, and in electric printing and signal telegraphs."—Sealed May 27.

Richard Henry Billiter, of Maze pond, Southwark, oil merchant, for "improvements in filtering oils."—Sealed May 27.

Arthur Hill, of the Slad Parsonage, near Stroud, Gloucester, clerk, for "an improved shower bath."—Sealed May 27.